PB-240 034

RADIOLOGICAL HEALTH DATA. VOLUME 2,
NUMBERS 1-3, JANUARY-MARCH 1961

Public Health Service
Washington, D. C.

March 1961

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NTIS
National Technical Information Service
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BIBLIOGRAPHIC DATA SHEET

1. Report No. RHD 2, (1-3)

2.

PB 240 034

4. Title and Subtitle
Radiological Health Data
Volume 2, Nos 1-3

5. Report Date Jan-Mar 1961

6.

7. Author(s)
None

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
U.S. Department of Health, Education, and Welfare
Public Health Service
Washington, D. C. 20201

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
U.S. Environmental Protection Agency
Office of Radiation Programs
401 M St., S. W.
Washington, D. C. 20460

13. Type of Report & Period Covered
Final: Jan-Mar 1961

14.

15. Supplementary Notes

16. Abstracts

Data and interpretation of data on radiation exposure to humans and on radioactivity in milk, water, air, and other environmental media are presented.

17. Key Words and Document Analysis. 17a. Descriptors

Radiation
Radioactivity
Air
Water
Milk
Food
Human

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

PRICES SUBJECT TO CHANGE

18. Availability Statement
Release unlimited

1<

19. Security Class (This Report)
UNCLASSIFIED

20. Security Class (This Page)
UNCLASSIFIED

21. No. of Pages 177

22. Price $7.00/2.25

2<

RADIOLOGICAL HEALTH DATA

QUARTERLY REPORT

JANUARY 1961

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Radiological Health

PREFACE

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data is provided to the Division of Radiological Health by other Federal agencies, State health departments, and by foreign governments. Except where material is directly quoted, summaries are prepared by the staff of the Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
Atomic Energy Commission
Department of Defense
Department of Commerce
Department of Agriculture

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SECTION I.—AIR

PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in environmental radiation due to radioactive fallout from nuclear weapons tests. Although no nuclear tests have been conducted by the United States since 1958, the program has proven sufficiently valuable that it has been extended to a round-the-year basis and currently consists of 45 stations at urban locations (see figure 1) operated by State and local health department personnel with 2 stations operated by U. S. Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment, and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. However, field measurements do enable the operator to estimate the amount of beta activity of particulates in the air at the station five hours after collection, by comparison to a known source, using a portable survey meter. The filters are then forwarded to a laboratory in Washington, D. C., for a more refined measurement using a thin window proportional counter.

Air samplers are in operation at the 45 stations on an average of 70 percent of the week. Air is drawn through a cellulose carbon loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small dust-like particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples.

About 85 percent of the stations collect samples of precipitation which are sent to Washington, D. C., for analysis. Values are now below limits of detection by present instrumentation. New equipment is being procured to measure lower values. Measurements have indicated that the bulk of deposited activity occurs through precipitation but concentrations in surface air are not directly relatable to the amount deposited through precipitation.

Table 1 presents a summary of the latest monthly data on gross beta radioactivity. Table 2 presents daily measurements of radon, thoron, and gross beta activity at the Network's Cincinnati, Ohio station.

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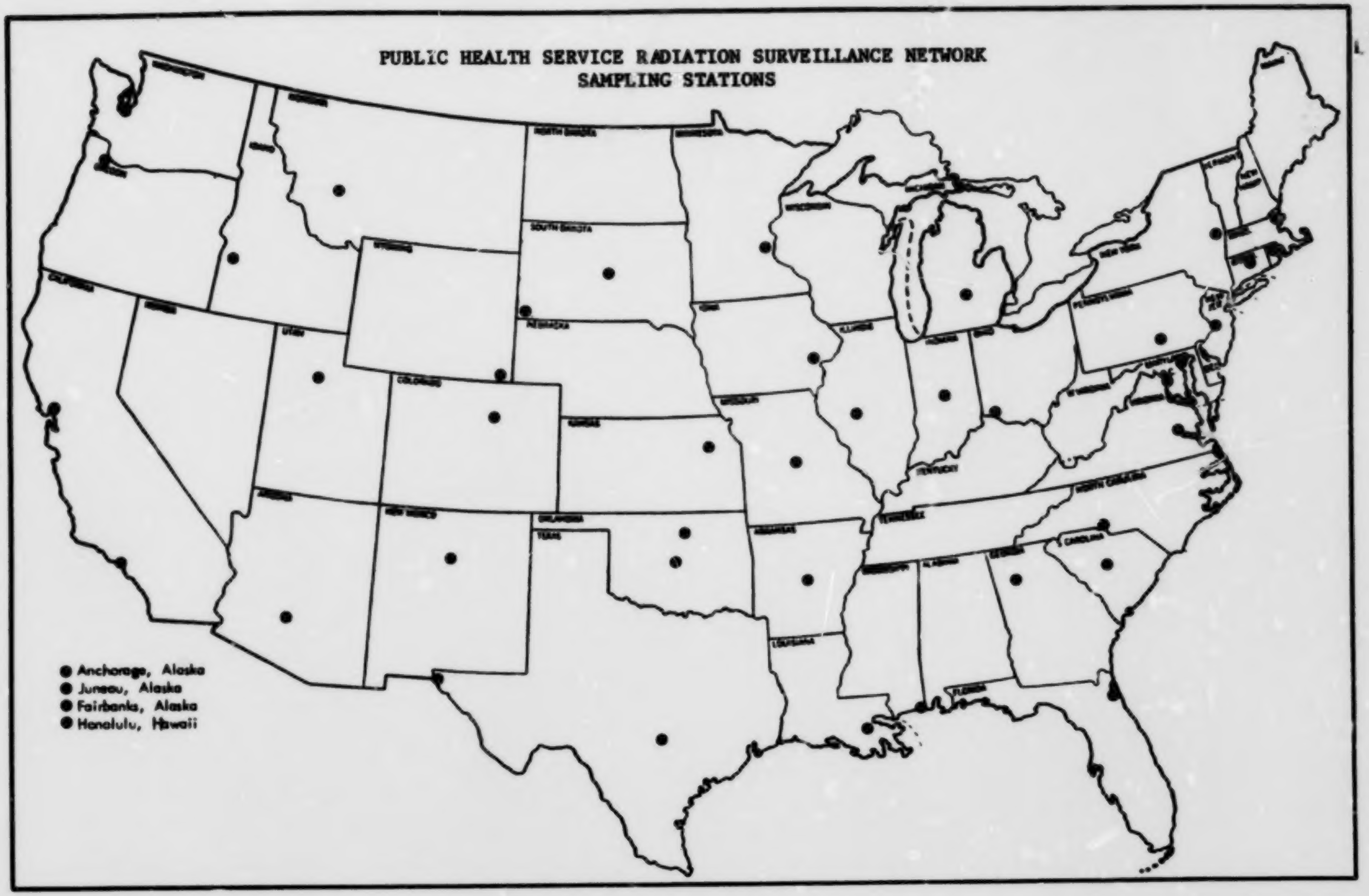
PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK
SAMPLING STATIONS
● Anchorage, Alaska
● Juneau, Alaska
● Fairbanks, Alaska
● Honolulu, Hawaii

FIGURE 1

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TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR—GROSS BETA COUNTS

Public Health Service Radiation Surveillance Network

August 1960

Station location	Weighted average $\mu\mu c/m^3$	Maximum $\mu\mu c/m^3$	Minimum $\mu\mu c/m^3$
Alaska, Anchorage	< 0.10	< 0.10	< 0.10
Alaska, Fairbanks	< 0.10	0.12	< 0.10
Alaska, Juneau	< 0.10	< 0.10	< 0.10
Arizona, Phoenix	< 0.10	0.12	< 0.10
Arkansas, Little Rock	< 0.11	0.16	< 0.10
California, Berkeley	< 0.10	< 0.10	< 0.10
California, Los Angeles	< 0.10	0.12	< 0.10
Colorado, Denver	< 0.12	0.17	< 0.10
Connecticut, Hartford	< 0.11	0.22	< 0.10
District of Columbia	< 0.12	0.21	< 0.10
Florida, Jacksonville	< 0.10	0.11	< 0.10
Georgia, Atlanta	0.08	0.19	0.02
Hawaii, Honolulu	< 0.10	< 0.10	< 0.10
Idaho, Boise	< 0.12	0.19	< 0.10
Illinois, Springfield	< 0.17	0.26	< 0.10
Indiana, Indianapolis	< 0.11	0.20	< 0.10
Iowa, Iowa City	< 0.13	0.18	< 0.10
Kansas, Topeka	< 0.11	0.15	< 0.10
Louisiana, New Orleans	< 0.10	0.10	< 0.10
Maryland, Baltimore	< 0.11	0.17	< 0.10
Massachusetts, Lawrence	< 0.10	0.13	< 0.10
Michigan, Lansing	< 0.11	0.22	< 0.10
Minnesota, Minneapolis	< 0.11	0.13	< 0.10
Mississippi, Pascagoula	< 0.11	0.18	< 0.10
Missouri, Jefferson City	< 0.11	0.16	< 0.10
Montana, Helena	< 0.11	0.16	< 0.10
New Jersey, Trenton	< 0.16	0.38	< 0.10
New Mexico, Santa Fe	< 0.12	0.17	< 0.10
New York, Albany	< 0.11	0.20	< 0.10
North Carolina, Gastonia	< 0.11	0.15	< 0.10
Oklahoma, Oklahoma City	< 0.11	0.16	< 0.10
Oklahoma, Ponca City	< 0.10	< 0.10	< 0.10
Oregon, Portland	< 0.10	0.21	< 0.10
Pennsylvania, Harrisburg	< 0.12	0.22	< 0.10
Rhode Island, Providence	< 0.12	0.18	< 0.10
South Carolina, Columbia	< 0.10	0.10	< 0.10
South Dakota, Edgemont	-	-	
South Dakota, Pierre	< 0.13	0.16	< 0.10
Texas, Austin	< 0.10	< 0.10	< 0.10
Texas, El Paso	< 0.12	0.16	< 0.10
Utah, Salt Lake City	< 0.12	0.34	< 0.10
Virginia, Richmond	< 0.11	0.13	< 0.10
Washington, Seattle	< 0.10	< 0.10	< 0.10
Wyoming, Cheyenne	< 0.10	0.10	< 0.10

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TABLE 2.–RADON AND THORON MEASUREMENTS

Public Health Service Radiation Surveillance Network Station at Cincinnati, Ohio

August 1960

Date	Continuous sample collection			Radon(a) AM μμc/m^3	Radon(b) PM μμc/m^3	Thoron(c) μμc/m^3	Beta(d) activity μμc/m^3
	Sample change time	Sampling period (hours)	Volume m^3				
August 1	0820	72.0	82.5	467	155	6.2	0.9
2	0820	23.9	27.8	868	191	9.8	3.5
3	0825	24.0	27.5	382	214	6.5	2.2
4	0825	23.9	29.0	228	184	4.8	2.1
5	0815	23.8	28.8	842	148	9.5	0.1 (3)
8	0825	72.2	85.8	327	148	4.7	0.8
9	0825	24.0	29.1	665	256	7.4	2.7
10	0825	23.9	29.0	371	156	2.2	0.9
11	0820	23.8	29.1	426	135	2.8	1.2
12	0815	23.8	28.8	814	138	3.5	0.1 (3)
15	0820	71.9	86.7	310	249	3.8	0.8
16	0820	23.9	29.4	249	170	2.4	1.0
17	0830	24.1	29.2	627	183	5.1	3.2
18	0825	23.8	29.1	660	143	6.1	3.9
19	0800	23.1	28.0	665	220	6.6	0.4 (3)
22	0830	72.4	88.6	411	157	3.0	0.6
23	0825	23.8	29.0	527	98	3.8	2.3
24	0813	22.5	25.8	506	99	3.9	2.4
25	0830	24.2	27.2	565	134	5.5	1.4
26	0820	23.3	28.0	761	133	7.5	0.3 (3)
29	0825	72.0	86.4	304	92	7.5	1.1
30	0815	23.8	29.3	394	93	4.8	2.2
31	0807	23.8	29.0	435	162	3.7	2.0
	Average			580	159	5.7	1.2

(a) Measured within a few minutes of removal of filter from sampler and corrected back to collection time (uncorrected for thoron daughter interference).

(b) Filters are temporarily withdrawn from sampler at about 3 p.m. and counted. (Values are corrected back to removal time.) The filters are then replaced on sampler to complete the sampling period of about 24 hours. Thus, the values in this column are from the same filters that are counted at about 8 a.m. the following day.

(c) Thoron from alpha activity of filter sample counted 7 hours after taking a 24-96 hour sample.

(d) Gross beta activity when counted one day after end of sampling or later as indicated by numeral in parenthesis. This activity is due principally to thoron except when counted after 3 or more days.

PUBLIC HEALTH SERVICE NATIONAL AIR SAMPLING NETWORK

The Public Health Service developed its National Air Sampling Network in 1953 to secure basic data on the nature and extent of air pollution throughout the United States, and to detect trends in levels of pollution with respect to time, location, population density, climate, and other factors associated with air quality.

The current basic network consists of 103 sampling statins operating every year in 66 large cities and 37 nonurban areas. In addition to these every-year stations, 126 cities have stations which operate every other year. Thus, there are 229 sampling stations in all, of which about 166 are active in any given year. A list of National Air Sampling Netowrk Stations appeared in the May 1960 issue of Radiological Health Data.

The Network stations are manned by cooperating federal, state, and local agencies. Twenty-four hour samples of suspended particulate matter representing approximately 2000 cubic meters of air are collected on glass fiber filters on a bi-weekly random sampling schedule. The analyses of these samples include the measurement of total quantity of suspended particulate matter, the organic matter soluble in benzene, and gross beta radioactivity. Selected samples are analyzed also for nitrates and sulfates, and for a number of metals.

Quarterly reports of individual sample data and annual summaries are distributed to all participating agencies and state health departments. A comprehensive report on the first five years of operation of the Network is contained in the publication, Air Pollution Measurements of the National Air Sampling Network, Public Health Service Publication No. 637, 1958; for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., price $2.00. Gross beta activity, by States, for the years 1953 through 1958 was submitted by Dr. F. J. Weber, Chief of the Division of Radiological Health, Public Health Service, in testimony before the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 173-185.

The 1959 quarterly and yearly averages of the gross beta activity of particulates in air were published in the October 1960 Radiological Health Data, and the first and second quarterly averages for 1960 gross beta activity of particulates in air were published in the November issue. Table 1, which follows, presents the third quarterly averages for 1960.

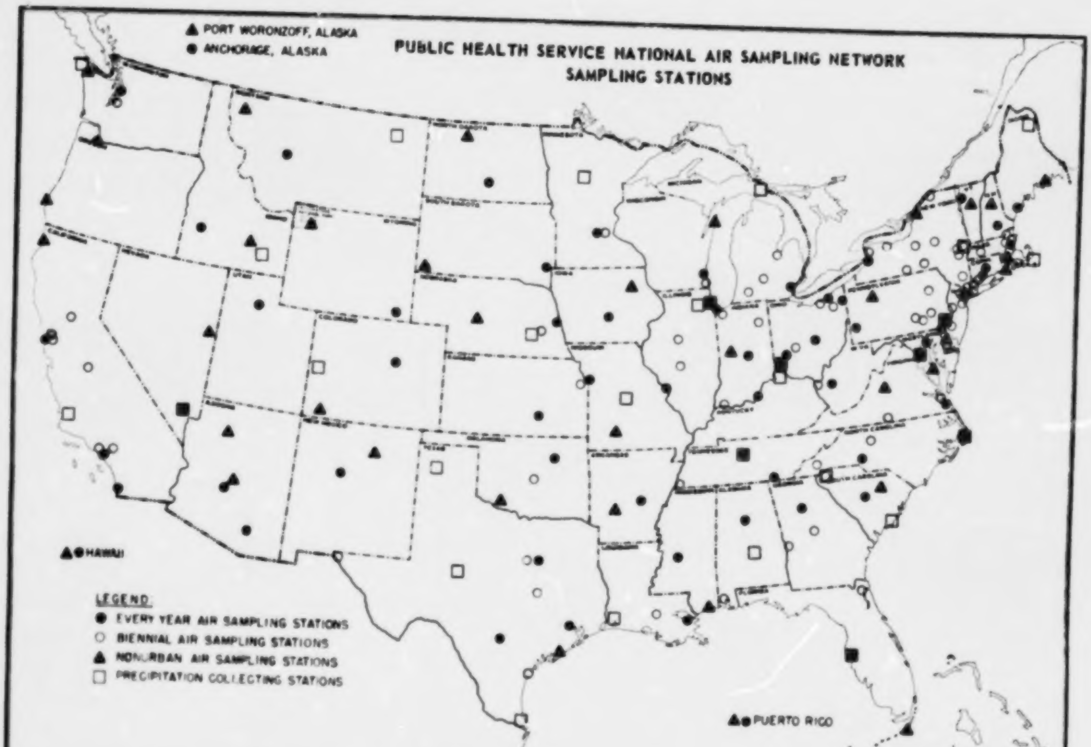
PUBLIC HEALTH SERVICE NATIONAL AIR SAMPLING NETWORK
SAMPLING STATIONS
▲ PORT WORONZOFF, ALASKA
● ANCHORAGE, ALASKA
▲● HAWAII
▲● PUERTO RICO
LEGEND:
● EVERY YEAR AIR SAMPLING STATIONS
○ BIENNIAL AIR SAMPLING STATIONS
▲ NONURBAN AIR SAMPLING STATIONS
☐ PRECIPITATION COLLECTING STATIONS

FIGURE 1

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TABLE 1.–GROSS BETA RADIOACTIVITY IN AIR

National Air Sampling Network
Public Health Service

Third Quarter 1960

(μμc per cubic meter)

Station location	Number of samples	Minimum	Maximum	Average
Hartford, Conn.	7	(**)	0.2	0.1
New Haven, Conn.	7	0.1	0.1	0.1
Stamford, Conn.	7		0.2	0.1
Bridgeport, Conn.	7		0.1	0.1
Portland, Maine	6		0.2	0.1
*Acadia Nat. Pk., Maine	7	0.1	0.2	0.1
Boston, Mass.	7		0.2	0.1
Lawrence, Mass.	7		0.2	0.1
Lynn, Mass.	7		0.1	0.1
Somerville, Mass.	6		0.2	0.1
Fall River, Mass.	7		0.3	0.1
Quincy, Mass.	6	0.1	0.3	0.2
Springfield, Mass.	6	0.1	0.3	0.2
Manchester, N. H.	3	0.1	0.3	0.2
*Coos County, N. H.	6		0.2	0.1
Providence, R. I.	7		0.2	0.1
*Washington Co., R. I.	7		0.2	0.1
Burlington, Vt.	6		0.2	0.1
*Orange County, Vt.	7	0.1	0.3	0.1
Wilmington, Del.	6		0.2	0.1
*Kent County, Del.	6		0.2	0.1
Elizabeth, N. J.	7		0.2	0.1
Camden, N. J.	6		0.2	0.1
Trenton, N. J.	5		0.2	0.1
East Orange, N. J.	5		0.1	0.1
Newark, N. J.	7	0.1	0.1	0.1
New York, N. Y.	7	0.1	0.3	0.1
Binghamton, N. Y.	7	0.1	0.1	0.1
Schenectady, N. Y.	6	0.1	0.2	0.1
Syracuse, N. Y.	6		0.2	0.1
Utica, N. Y.	6		0.1	0.1
Albany, N. Y.	7	0.1	0.2	0.1
Rochester, N. Y.	7	0.1	0.2	0.1
Niagara Falls, N. Y.	5	0.1	0.5	0.2
New Rochelle, N. Y.	6	0.1	0.2	0.1
Troy, N. Y.	5		0.1	0.1
Massena, N. Y.	7	0.1	0.2	0.1
Glen Cove, N. Y.	5		0.1	0.1
Elmira, N. Y.	6	0.1	0.1	0.1
Mt. Vernon, N. Y.	7	0.1	0.2	0.1
*Cape Vincent, N. Y.	7		0.1	0.1
East Chicago, Ind.	5	0.1	0.1	0.1
Evansville, Ind.	7	0.1	0.8	0.2
Fort Wayne, Ind.	7	0.1	0.3	0.1
Indianapolis, Ind.	7	0.1	0.3	0.2
Gary, Ind.	7	0.1	0.2	0.1
*Montgomery Co., Ind.	7	0.1	0.2	0.1
Detroit, Mich.	7	0.1	0.3	0.1
Kalamazoo, Mich.	7	0.1	0.3	0.2
Lansing, Mich.	7	0.1	0.2	0.1
Saginaw, Mich.	7	0.1	0.3	0.2

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TABLE 1.–GROSS BETA RADIOACTIVITY IN AIR–Con.

National Air Sampling Network
Public Health Service

Third Quarter 1960

(μμc per cubic meter)

Station location	Number of samples	Minimum	Maximum	Average
Cincinnati, Ohio	7	0.1	0.3	0.2
Youngstown, Ohio	7	0.1	0.1	0.1
Cleveland, Ohio	7	0.1	0.3	0.2
Columbus, Ohio	7	0.1	0.1	0.1
Lorain, Ohio	6	0.1	0.2	0.1
Akron, Ohio	7	0.1	0.2	0.2
Dayton, Ohio	7	0.1	0.2	0.1
Springfield, Ohio	7	0.1	0.3	0.2
Milwaukee, Wis.	6		0.1	0.1
Racine, Wis.	6	0.1	0.3	0.2
*Door County, Wis.	7		0.1	0.1
Des Moines, Iowa	7	0.1	0.3	0.2
*Clayton County, Iowa	7	0.1	0.2	0.1
Kansas City, Kans.	7	0.1	0.2	0.2
Wichita Kans.	6	0.1	0.2	0.1
Minneapolis, Minn.	6	0.1	0.1	0.1
St. Paul, Minn.	7	0.1	0.2	0.1
Kansas City, Mo.	7	0.1	0.3	0.2
St. Louis, Mo.	7		0.3	0.1
*Shannon County, Mo.	1	0.2	0.2	0.2
Omaha, Nebr.	7		0.2	0.1
Lincoln, Nebr.	7	0.1	0.3	0.2
Thomas County, Nebr.	6	0.1	0.2	0.2
Bismarch, N. Dak.	7		0.2	0.1
*Ward County, N. Dak.	6		0.2	0.1
Sioux Falls, S. Dak.	6		0.2	0.1
*Black Hills Forest, S. Dak.	5	0.1	0.2	0.1
Little Rock, Ark.	7		0.2	0.1
*Montgomery County, Ark.	7		0.2	0.1
New Orleans, La.	7		0.2	0.1
Baton Rouge, La.	7		0.1	0.1
Albuquerque, N. Mex.	7	0.1	0.5	0.2
Philadelphia, Pa.	7	0.1	0.2	0.1
Pittsburgh, Pa.	6	0.1	0.2	0.2
Lancaster, Pa.	4	0.1	0.3	0.2
Harrisburg, Pa.	7	0.1	0.2	0.1
Reading, Pa.	6	0.1	0.2	0.1
Wilkes Barre, Pa.	6	0.1	0.2	0.1
*Clarion County, Pa.	7	0.1	0.2	0.1
Washington, D. C.	5	0.1	0.2	0.1
Louisville, Ky.	4		0.2	0.1
Baltimore, Md.	6		0.2	0.1
*Calvert County, Md.	5		0.1	0.1
Charlotte, N. C.	6	0.1	0.2	0.1
Winston Salem, N. C.	7	0.1	0.2	0.1
Asheville, N. C.	7	0.1	0.2	0.1
*Cape Hatteras, N. C.	6		0.1	0.1
San Juan, P. R.	6		0.1	0.1
*Loquillo Mountains, P. R.	6		0.1	0.1
Norfolk, Va.	7		0.1	0.1
Hampton, Va.	6	0.1	0.2	0.2

13<

TABLE 1.–GROSS BETA RADIOACTIVITY IN AIR–Con.

National Air Sampling Network
Public Health Service

Third Quarter 1960

(µµc per cubic meter)

Station location	Number of samples	Minimum	Maximum	Average
Danville, Va.	6	0.1	0.2	0.1
*Shenandoah National Park, Va.	6		0.3	0.1
Charleston, W. Va.	6	0.1	0.2	0.1
Huntington, W. Va.	7	0.1	0.3	0.1
Birmingham, Ala.	7		0.2	0.1
Mobile, Ala.	7		0.2	0.1
Tampa, Fla.	7		0.1	0.1
Jacksonville, Fla.	7		0.1	0.1
*Florida Keys, Fla.	4		0.1	
Atlanta, Ga.	5	0.1	0.1	0.1
Columbus, Ga.	6	0.1	0.2	0.1
Macon, Ga.	7		0.4	0.2
Jackson, Miss.	6		0.1	0.1
*Jackson County, Miss.	4		0.1	0.1
Columbia, S. C.	4	0.1	0.2	0.2
Greenville, S. C.	6		0.2	0.1
*Richland County, S. C.	6	0.1	0.3	0.2
Chattanooga, Tenn.	7	0.1	0.2	0.1
Nashville, Tenn.	7		0.2	0.1
Memphis, Tenn.	7		0.3	0.1
Chicago, Ill.	5	0.1	0.2	0.2
Springfield, Ill.	5		0.3	0.1
Peoria, Ill.	7	0.1	0.3	0.2
*Colfax County, N. Mex.	4		0.3	0.1
Tulsa, Okla	4	0.1	0.2	0.1
Oklahoma City, Okla.	7		0.2	0.1
*Cherokee Co., Okla.	7		0.2	0.1
Ft. Worth, Tex.	7		0.1	0.1
Houston, Tex.	7		0.1	0.1
Dallas, Tex.	5	0.1	0.1	0.1
San Antonio, Tex.	6		0.2	0.1
El Paso, Tex.	7		0.2	0.1
Corpus Christie	7		0.1	
Waco, Tex.	6		0.2	0.1
*Calhoun County, Tex.	3	0.1	0.1	0.1
Denver, Colo.	6	0.1	0.2	0.1
*Montezuma County, Colo.	6		0.1	0.1
Boise, Idaho	7	0.1	0.3	0.1
*Butte County, Idaho	4	0.1	0.2	0.2
Helena, Mont.	7	0.1	0.3	0.2
*Glacier National Park, Mont.	8	0.1	0.4	0.2
Salt Lake City, Utah	6	0.1	0.3	0.2
Cheyenne, Wyo.	4		0.1	0.1
*Yellowstone Park, Wyo	7		0.2	0.1
Anchorage, Alaska	7			
*Pt. Woronzof, Alaska	7		0.1	
Phoenix, Ariz.	6	0.1	0.3	0.1
Tucson, Ariz.	6	0.1	0.2	0.1
*Maricopa Co., Ariz.	6	0.1	0.2	0.1
*Grand Canyon Park, Ariz.	3	0.1	0.3	0.2
Los Angeles, Calif.	6	0.1	0.1	0.1
San Francisco, Calif.	7		0.1	0.1
Pasadena, Calif.	7	0.1	0.2	0.1

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TABLE 1.—GROSS BETA RADIOACTIVITY IN AIR—Con.

National Air Sampling Network
Public Health Service

Third Quarter 1960

(μμc per cubic meter)

Station location	Number of samples	Minimum	Maximum	Average
San Diego, Calif.	7	0.1	0.1	0.1
Burbank, Calif.	7		0.2	0.1
Fresno, Calif.	7	0.1	0.2	0.2
Oakland, Calif.	7		0.1	0.1
Sacramento, Calif.	7		0.1	0.1
Richmond, Calif.	7		0.1	0.1
*Humboldt County, Calif.	4			
Honolulu, Hawaii	7		0.1	0.1
*Barbers Point, Ewa County, Hawaii	7		0.1	0.1
Las Vegas, Nev.	7		0.4	0.2
*White Pine County, Nev.	5	0.1	0.2	0.1
Portland, Oreg.	6		0.1	0.1
*Curry County, Oreg.	5		0.1	0.1
Tacoma, Wash.	7	0.1	0.2	0.1
*Clallam County, Wash.	1	0.1	0.1	0.1

*Nonurban station.

**A blank space in the table indicates that the level was below the minimum detectable value of 0.1 μμc/m³.

GROSS BETA RADIOACTIVITY IN PRECIPITATION

National Air Sampling Network
Precipitation Collection Section
Public Health Service

During 1959 a precipitation collection and analysis program was established by the Weather Bureau Research Station in Cincinnati, Ohio, and the National Air Sampling Network. The collection stations are located at Weather Bureau Offices or Airport Stations. Monthly composite samples of precipitation are collected at 29 stations and forwarded to the Network laboratory for analysis. A list of these precipitation collection stations is given below. Samples are analyzed for total solids and a large number of metals and nonmetals. In addition, samples representing 85% or more of the official rainfall recorded at the collecting stations are analyzed for gross beta radioactivity if a large enough volume remains after the needs for the chemical analysis have been met.

Quarterly data on gross beta radioactivity of precipitation will be published in the Radiological Health Data Quarterly Reports. Table 1 presents the data for the third quarter 1960.

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TABLE 1.–GROSS BETA RADIOACTIVITY OF PRECIPITATION

National Air Sampling Network
Public Health Service

Third Quarter 1960

Station location	July		August		September	
	μμc/liter	μμc/m^2	μμc/liter	μμc/m^2	μμc/liter	μμc/m^2
Albany, New York	23	3,100	-	-	4	800
Brownsville, Texas	-	-	-	-	3	300
Cape Hatteras, North Carolina	14	2,100	15	1,400	15	1,000
Charleston, West Virginia	5	1,600	10	700	5	900
Chicago, Illinois (Midway Airport)	25	2,000	-	-	-	-
Chicago, Illinois (O'Hare Airport)	21	2,200	-	-	-	-
Cincinnati, Ohio (Airport)	16	2,000	-	-	-	-
Cincinnati, Ohio (WBRS)	17	1,400	13	2,000	-	-
Columbia, Missouri	40	3,200	-	-	-	-
Grand Island, Nebraska	36	2,700	13	700	15	800
Greenville, South Carolina	16	1,900	15	1,800	14	1,500
Lake Charles, Louisiana	-	-	6	900	1	100
Montgomery, Alabama	-	-	-	-	9	1,300
Nantucket, Maine	-	-	-	-	5	300
Nashville, Tennessee	-	-	-	-	4	400
Philadelphia, Pennsylvania	34	4,400	-	-	-	-
St. Cloud, Minnesota	-	-	9	1,000	-	-
Sault Ste. Marie, Michigan	15	1,100	-	-	-	-
Tampa, Florida	6	2,800	-	-	-	-
Washington, D. C.	8	800	16	2,300	-	-

- No data available due to low collection efficiency or inadequate sample.

NAVAL RESEARCH LABORATORY RADIOACTIVITY MEASUREMENTS

Radioactivity measurements of air-filter samples collected at various sites along the 80th Meridian (West) are made by the U. S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during August 1960 is shown in Table 1, while the radioactivity profile for the same month is shown in Figure 1. All radioactivity concentrations are given in disintegrations per minute per cubic meter of air at the collecting site. (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter.)

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TABLE 1.--DAILY RECORD OF FISSION PRODUCT B-ACTIVITY COLLECTED BY AIR FILTRATION

U. S. Naval Research Laboratory

August 1960

(Disintegrations/minute per cubic meter)

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador
1	0.02	0.01	-	0.08	0.07	0.04	0.11
2	-	0.02	0.13	-	0.04	Tr	0.09
3	-	0.02	0.13	-	0.04	Tr	0.04
4	-	0.01	0.11	0.23	0.05	0.02	0.04
5	-	0.01	0.11	0.23	0.05	0.02	0.05
6	0.01	0.03	0.08	0.12	0.02	0.03	0.05
7	0.01	0.03	0.08	0.12	0.02	0.03	0.05
8	0.01	0.03	0.08	0.12	0.02	0.03	0.05
9	Tr	0.03	0.09	0.08	0.06	0.04	0.05
10	Tr	0.03	0.09	0.08	0.06	0.04	0.04
11	0.07	0.07	0.07	0.07	0.08	0.09	0.04
12	0.07	0.07	0.07	0.07	0.08	0.09	0.04
13	0.02	0.03	0.08	0.06	0.03	0.01	0.05
14	0.02	0.03	0.08	0.06	0.03	0.01	0.02
15	0.02	0.03	0.08	0.06	0.03	0.01	0.02
16	0.03	0.02	0.07	0.09	0.06	0.05	0.05
17	0.03	0.02	0.07	0.09	0.06	0.05	0.07
18	-	0.01	0.05	0.10	0.06	0.01	0.02
19	-	0.01	0.05	0.10	0.06	0.01	0.07
20	-	0.05	0.07	0.09	0.07	Tr	0.04
21	-	0.05	0.07	0.09	0.07	Tr	0.04
22	-	0.05	0.07	0.09	0.07	Tr	0.04
23	-	0.04	-	0.08	0.07	0.04	0.05
24	-	0.04	-	0.08	0.07	0.04	0.05
25	-	0.04	0.17	0.12	0.04	0.07	0.07
26	-	0.04	0.17	0.12	0.04	0.07	0.07
27	-	-	0.10	0.05	0.09	0.02	0.04
28	-	-	0.10	0.05	0.09	0.02	0.04
29	-	-	0.10	0.05	0.09	0.02	0.06
30	-	-	0.07	0.05	0.09	0.06	0.06
31	-	-	0.07	0.05	0.09	0.06	0.09
Mean value	0.02	0.03	0.09	0.09	0.06	0.03	0.05

Tr--Trace.

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TABLE 1.–DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION--Con.

U. S. Naval Research Laboratory

August 1960

(Disintegrations/minute per cubic meter)

Day	Miraflores, Panama Canal	Mauna Loa, Hawaii	Miami, Florida	Washington, D. C.	Moosonee, Ontario, Canada	Thule, Greenland	Bravo, Artic Ice Floe
1	0.03	0.09	0.08	0.37	0.26	0.54	0.02
2	0.05	0.08	0.13	0.40	0.12	0.28	0.04
3	0.05	0.08	0.13	0.40	0.12	0.28	0.04
4	0.02	0.11	0.10	0.23	0.08	0.04	0.04
5	0.02	0.11	0.10	0.23	0.08	0.04	0.04
6	0.05	0.07	0.09	0.14	0.11	0.04	0.04
7	0.05	0.07	0.09	0.14	0.11	0.04	0.04
8	0.05	0.07	0.09	0.14	0.11	0.04	0.04
9	0.05	0.15	0.09	0.25	0.09	0.26	0.03
10	0.05	0.15	0.09	0.25	0.09	0.26	0.03
11	0.02	0.11	0.15	0.20	0.17	0.15	0.03
12	0.02	0.11	0.15	0.20	0.17	0.15	0.03
13	0.02	0.06	0.17	0.17	0.13	0.12	0.03
14	0.02	0.06	0.17	0.17	0.13	0.12	0.03
15	0.02	0.06	0.17	0.17	0.13	0.12	0.03
16	0.05	0.07	0.20	0.24	0.10	0.22	0.01
17	0.05	0.07	0.20	0.24	0.10	0.22	0.01
18	0.05	0.23	0.21	0.29	-	0.05	0.01
19	0.05	0.23	0.21	0.29	-	0.05	0.01
20	0.06	0.23	0.21	0.30	0.25	0.07	0.01
21	0.06	0.23	0.21	0.30	0.25	0.07	0.01
22	0.06	0.23	0.21	0.30	0.25	0.07	0.01
23	0.04	0.13	0.12	0.27	0.10	0.13	0.04
24	0.04	0.13	0.12	0.27	0.10	0.13	0.04
25	0.05	0.10	0.06	0.27	0.28	0.18	0.04
26	0.05	0.10	0.06	0.27	0.28	0.18	0.04
27	0.01	0.10	0.15	0.25	0.19	0.20	0.04
28	0.01	0.10	0.15	0.25	0.19	0.20	0.04
29	0.01	0.10	0.15	0.25	0.19	0.20	0.04
30	0.01	-	0.08	0.16	0.20	0.12	0.02
31	0.01	-	0.08	0.16	0.20	0.12	0.02
Mean value	0.05	0.12	0.14	0.24	0.16	9.15	0.03

Tr--Trace.

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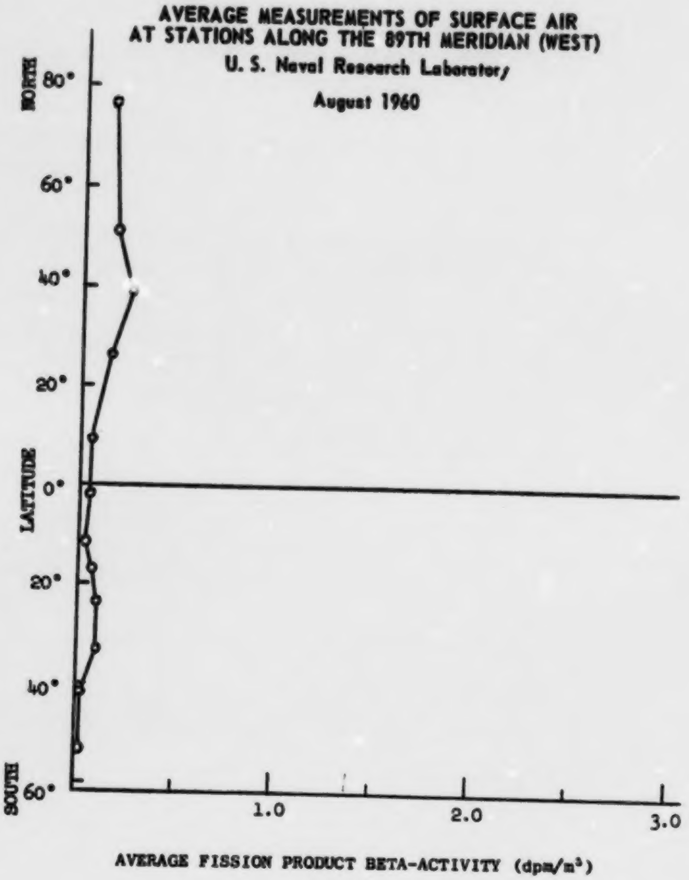
AVERAGE MEASUREMENTS OF SURFACE AIR AT STATIONS ALONG THE 89TH MERIDIAN (WEST)

U. S. Naval Research Laboratory

August 1960

FIGURE 1

CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM

Department of National Health and Welfare
Dominion of Canada

As part of its radioactive fallout study program, the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada conducts air and precipitation sampling programs.

The operation of the nation-wide air sampling program is conducted for two main purposes: (1) To provide a convenient method for the early detection of changes in the fission product concentration in the air and therefore of likely changes in the deposition of fission products on the ground, and (2) To obtain data to show the day to day and station to station variations. This may be useful to meteorologists in a better understanding of the mechanisms involved in radioactive fallout distribution in the atmosphere.

A more detailed discussion of the sampling procedures, methods of analysis, and interpretation of results of the Department's radioactive fallout program is contained in the "Annual Report for 1959," Report Number CNHW (RP-3).

Tables 1 and 2 give the data on total beta activity in air for the period of July 1959-June 1960. Tables 3 and 4 give the data on total beta activity in precipitation for January-December 1959 and January-June 1960.

These data are reproduced in the present form through the permission of the Department of National Health and Welfare, Dominion of Canada.

TABLE 1.–TOTAL BETA RADIOACTIVITY IN AIR

Canadian Radioactive Fallout Study Program

July 1959-June 1960

Station location	Monthly average in dpm/m^3											
	July	August	September	October	November	December	January	February	March	April	May	June
Aklavik	0.90	0.50	0.54	0.25	0.37	0.27	0.28	0.37	0.42	0.50	0.37	0.27
Calgary	-	-	0.11	0.32	0.37	0.32	0.32	0.36	0.54	0.60	0.51	0.49
Chatham	-	-	-	-	-	-	-	0.23	0.38	0.37	0.33	0.43
Coral Harbour	-	0.76	0.35	0.26	0.27	0.37	0.25	0.33	0.39	0.53	0.33	0.35
Edmonton	1.79	0.92	0.51	0.34	0.30	0.32	0.28	0.36	0.48	0.55	0.40	0.38
Fort Churchill	-	-	-	-	-	0.27	0.26	0.48	0.42	0.68	0.35	0.32
Fort William	-	-	-	-	0.34	0.27	0.27	0.45	0.56	0.40	0.49	0.45
Fredericton	-	-	-	-	-	-	-	-	-	0.26	0.32	0.36
Kapuskasing	-	0.65	0.40	0.31	0.34	-	-	0.46	0.49	0.50	0.61	0.52
Montreal	-	-	0.62	0.30	0.30	-	-	0.25	0.37	0.40	0.41	0.57
Moosonee	-	0.58	0.46	0.30	0.26	0.28	0.25	0.42	0.44	0.44	0.42	0.42
Ottawa	2.33	1.52	1.17	0.29	0.34	0.28	0.23	0.25	0.69	0.37	0.54	0.56
Regina	-	1.13	0.55	0.30	0.29	0.26	0.33	0.41	0.44	0.45	0.53	0.46
Resolute	0.75	0.53	0.31	0.22	0.33	0.28	0.22	0.47	0.39	0.50	0.31	0.18
Saskatoon	-	-	-	-	0.25	0.29	0.31	0.43	0.46	0.54	0.54	0.50
Shearwater	-	-	-	-	-	-	-	-	-	0.36	0.35	0.31
Torbay	-	-	-	-	0.31	0.21	0.20	0.20	0.28	0.28	0.24	0.33
Toronto	-	-	0.82	0.40	0.32	-	-	0.31	0.45	0.48	0.44	0.58
Vancouver	-	-	-	0.27	0.27	0.20	0.18	0.35	0.47	0.33	0.23	0.26
Whitehorse	-	-	0.28	0.32	0.22	0.16	0.26	0.50	0.38	0.34	0.38	0.18
Windsor	-	-	0.54	0.35	0.35	0.29	0.31	0.37	0.52	0.57	0.50	0.64
Winnipeg	-	-	0.46	0.33	0.35	0.26	0.34	0.51	0.54	0.40	0.53	0.45
Yellowknife	-	1.04	0.50	0.28	0.33	0.29	0.36	0.49	0.42	0.51	0.46	0.47

TABLE 2.–MONTHLY AVERAGE FISSION PRODUCT CONCENTRATION IN AIR

Canadian Radioactive Fallout Study Program

July 1959-June 1960

(Radioactivity in dpm/m^3)

Month	Number of stations operating 50 percent of the time	Minimum average all stations	Maximum station average	Overall average
July 1959	0*	-	-	1.44
August 1959	7	0.50	1.52	0.85
September 1959	13	0.28	1.17	0.51
October 1959	16	0.22	0.40	0.30
November 1959	17	0.22	0.37	0.31
December 1959	17	0.16	0.37	0.27
January 1960	17	0.18	0.36	0.27
February 1960	21	0.20	0.51	0.38
March 1960	21	0.28	0.69	0.45
April 1960	22	0.28	0.68	0.46
May 1960	22	0.23	0.61	0.42
June 1960	23	0.18	0.64	0.41

*Four stations were operating for a short time during July.

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TABLE 3.–TOTAL BETA RADIOACTIVITY IN PRECIPITATION

Canadian Radioactive Fallout Study Program

January-December 1959

Station location	January		February		March		April		May		June	
	μμc/l	inches	μμc/l	inches	μμc/l	inches	μμc/l	inches	μμc/l	inches	μμc/l	inches
Aklavik												
Calgary												
Coral Harbor												
Dartmouth	221	4.3	251	3.01	194	5.77	257	8.92	188	2.21	188	7.81
Deep River							248	2.67	248	2.12	771	0.96
Edmonton	210	0.91	386	0.25	410	0.25	1,088	0.28	375	1.74	26	3.06
Fort Churchill	123	0.63	375	0.54	1,306	0.40	1,267	0.39	1,736	1.08	1,253	1.05
Fort William												
Kapuskasing												
La Durantye	68	4.27	204	2.38	128	3.98						
London	73	4.97	220	2.47	422	2.49	373	2.84	128	4.59	257	0.87
Montreal												
Moosonee												
Ottawa	27	3.12	245	3.14	450	2.28	1,050	1.25	772	0.95		
Regina												
Resolute												
Sable Island	120	5.44	25	6.98								
Saskatoon												
Sulphur Mountain			20	5.2					362	2.52	171	5.75
Torbay	127	5.00			22	5.12			296	2.22		
Toronto												
Vancouver												
Whitehorse												
Windsor												
Winnipeg	625	0.22	192	0.98	198	1.02						
Yellowknife												
Average	177		213		391		714		513		444	

Station location	July		August		September		October		November		December	
	μμc/l	inches	μμc/l	inches	μμc/l	inches	μμc/l	inches	μμc/l	inches	μμc/l	inches
Aklavik					68	2.52	29	1.5	69	0.73	47	0.64
Calgary					233	0.24	173	0.28	74	0.7	197	0.99
Coral Harbor			193	1.72			65	1.53	245	0.41	119	0.39
Dartmouth												
Deep River	871	1.92										
Edmonton			135	3.86			153	1.62	73	0.45	64	1.02
Fort Churchill											38	2.02
Fort William									30	1.77	37	1.40
Kapuskasing					49	3.11	21	5.46	32	2.74	17	1.09
La Durantye												
London												
Montreal					78	1.50	24	5.69	39	3.61	97	1.4
Moosonee			164	2.68	63	2.44	73	2.23	66	1.88	65	0.51
Ottawa			39	4.19	48	3.86	31	3.26	24	3.30	56	4.10
Regina					36	5.09	64	1.64	46	1.14	45	0.89
Resolute			74	0.89	91	1.4						
Sable Island												
Saskatoon											17	0.89
Sulphur Mountain												
Torbay	270	1.56	58	3.87	34	5.77	31	6.52	13	10.94		
Toronto					39	4.05	5	3.42				
Vancouver									20	6.18	32	5.60
Whitehorse					135	0.85	59	0.50	195	0.41	70	0.50
Windsor					31	3.34	20	5.00	30	3.08	17	3.12
Winnipeg					21	2.45	37	3.44	163	0.71	253	0.38
Yellowknife					47	1.83	48	2.66	40	1.48	19	0.89
Average	570		110		70		56		72		70	

Note: Blank space indicates no sample.

TABLE 4.–TOTAL BETA RADIOACTIVITY IN PRECIPITATION

Canadian Radioactive Fallout Study Program

January-June 1960

Station location	January		February		March		April		May		June	
	μμc/liter	inches	μμc/liter	inches	μμc/liter	inches	μμc/liter	inches	μμc/liter	inches	μμc/liter	inches
Aklavik	3.65	0.71			453.7	0.14	174	0.3	444.6	0.16	580	0.06
Calgary	298	.21	35	1.23			116	1.59	113	1.68	100	4.02
Chatham N.B.	0.15	6.88	20.4	6.88	10.6	9.72						
Coral Harbour	266	.22	81.6	.73	126.3	.26	23.9	2.02	118	.95	52.6	1.44
Edmonton	152	.26	53.7	.86	137.6	.38			88.1	2.72	65.8	2.86
Fredericton									37.5	5.25	64.5	2.95
Fort Churchill	55.3	1.30	7.1	2.90	50.6	.81	33.7	2.69	50.3	2.01		
Fort William	8.2	1.26	15.1	3.20	107.9	.59	57.8	2.45	44.4	3.32	78.9	2.44
Kapuskasing	35	1.70	7.4	3.00	96.5	1.17	166	1.17	75.6	2.57	52.8	1.99
Montreal	36.5	2.48	28.6	6.90	55	3.15	78.6	2.66	104	2.00	74.8	2.45
Moosonee	38.9	1.61	18.7	3.23	88.9	1.12						
Ottawa	65.7	1.53	23.6	5.10	56.8	1.95	64	2.58	82.3	3.18	52.1	3.03
Regina	60.3	.73	719	.45	482	.30	162	.86	71.3	2.30	65.4	5.19
Resolute							37.1	.60	53.1	3.60	68.3	0.26
Saskatoon	105	.44	23.3	.66	105.5	.69	160	.59	94.5	2.09	76.2	2.60
Shearwater N.S.							555	.11			52.6	3.44
Torbay	23.9	7.28	25.2	7.14	19	7.23	41.7	1.14	18	3.77	50.7	2.72
Toronto			32.4	3.27	27.2	1.85	94.2	2.63	79.9	4.08	97.2	2.33
Vancouver	17	6.47	23	4.92	31.5	4.24	54.9	1.77	57.4	3.43	140	.60
Whitehorse	87.3	.74			26	.79			56	.37	79.1	1.20
Windsor	25.8	3.19	56.1	2.07	27.7	2.04	46.7	1.67	68.5	2.54	36.3	6.38
Winnipeg	44.5	.69	223.6	.45	73	1.21	103	1.06	95.8	1.34	94.5	2.18
Yellowknife	76.8	.40	7.6	.80	31	.83	98.3	.13	105	.98	103	.54
Average	73.7		77.8		105.6		114.8		92.9		99.2	

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SECTION II.—FOOD, OTHER THAN MILK

SURVEY OF RADIOACTIVITY IN FOOD

Food and Drug Administration

As an index of fallout contamination, the Food and Drug Administration, U. S. Department of Health, Education, and Welfare has conducted surveys of total beta radioactivity in a variety of foods since 1957. Correction for potassium-40 has been made in the total beta radioactivity. The total potassium content was determined by flame photometry and the K^{40} contribution calculated using a known ratio of K^{40} to total potassium. This type of survey lends itself to the rapid analyses of many more samples than would be possible if individual nuclides such as strontium-90 were determined. Care has been taken to ensure that all samples from a given period were approximately the same age when analyzed. This permits meaningful interpretation of differences between varieties and growing areas

From June 1959 to June 1960, 23 samples of food were examined for total beta and strontium-90 and the results expressed as percent strontium-90 of total beta. The period of time during which this relationship was studied varied from 8 to 20 months following cessation of nuclear weapons testing. The total beta concentration therefore did not reflect the presence of shorter lived beta emitting nuclides. The relationship of strontium-90 to total beta in these 23 samples was found to average 9.5%. This compares to the average strontium-90 content of 9.8% in 17 samples of alfalfa, 9.6% in a second set of 24 samples of alfalfa, and 6.4% in 27 samples of corn ensilage collected during the same time period.

Tables 1 and 2 show the results of analyses of about 1000 samples of vegetables and 700 samples of fruits respectively. The survey represents fresh and processed samples. Vegetables carry a greater burden of radioactivity than fruits, and this is most notable in spinach, celery, lettuce, and greens. Lower values in 1959 are a reflection of the decay of the short lived components of fallout. Regional distribution of fallout contamination as reflected in this type of survey is shown in table 3.

Table 4 shows the results of a limited survey on sea food. Oysters and clams carry the largest burden of contamination. Attention is also called to the fact that the total beta radioactivity in these two sea foods has not materially decayed in 1959.

Table 5 shows in summary the analyses of a large number of tea samples originating from different parts of the world. Highest radioactivity is confined to Japanese, Formosan and Indian teas. It is noteworthy that the beta radioactivity has not shown any marked decline in the three sampling periods. The high total beta radioactivity reflects strontium-90 concentrations ranging as high as 1300 uuc/kg for tea from India as reported in Radiological Health Data, May 1960.

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TABLE 1.—TOTAL BETA RADIOACTIVITY IN VEGETABLES

Vegetable	Year	No. samples	Total beta dpm/gm
Spinach	1958	71	11.0
	1959	85	4.1
Celery	1958	67	7.4
	1959	70	3.2
Lettuce	1958	101	6.7
	1959	95	1.4
Greens*	1958	11	5.8
	1959	28	3.1
Green beans	1958	40	1.2
	1959	55	0.2
Beans (shelled)	1958 & 1959	24	1.9
Corn	1958	9	0.3
	1959	10	0.2
Brassica**	1958	134	1.1
	1959	213	0.4
Asparagus	1958 & 1959	12	0.5
Potatoes	1958 & 1959	31	0.0
Peas	1958 & 1959	11	0.0
Average			3.0

* Greens include kale, turnip greens, collards, mustard greens and dandelion.

** Brassica include broccoli, cabbage, cauliflower and brussel sprouts.

TABLE 2.—TOTAL BETA RADIOACTIVITY IN FRUITS

Fruits	Year	No. samples	Total beta dpm/gm
Plums & prunes	1958 & 1959	25	2.8
Strawberries	1958 & 1959	51	1.7
Dates & figs	1958	148	1.0
Berries*	1958 & 1959	42	0.8
Apples & pears	1958	94	0.4
	1959	102	0.0
Cherries	1958 & 1959	40	0.4
Grapes	1958 & 1959	35	0.4
Peaches & Apricots	1958 & 1959	50	0.4
		70	0.1
Tomatoes & peppers	1958 & 1959	34	0.3
		34	0.0
Average			0.4

* Berries include: blueberries, blackberries, gooseberries, raspberries, and dewberries.

TABLE 3.–TOTAL BETA RADIOACTIVITY IN FRUITS AND VEGETABLES BY AREAS

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Area	Year	Fruits*		Vegetables**	
		No. samples	Total beta dpm/gm	No. samples	Total beta dpm/gm
Northeast [(a)]	1958	38	0.6	89	1.9
	1959	48	0.2	185	0.8
North Central [(b)]	1958	65	0.7	116	4.7
	1959	101	0.9	177	1.7
South [(c)]	1958	45	0.6	54	3.3
	1959	70	0.6	142	1.4
West [(d)]	1958	97	0.6	237	7.4
	1959	92	0.0	192	2.4

(a) Northeast Area consists of: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania.

(b) North Central Area consists of: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas.

(c) South Area consists of: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas.

(d) West Area consists of: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, and California.

*Fruits include: grapes, peaches, berries, apples, cherries, tomatoes, plums, apricots, nectarines, etc.

**Vegetables include: corn, spinach, green beans, cabbage, broccoli, potatoes, peas, kale, brussel sprouts, celery, cauliflower, asparagus, peppers, lettuce, beans, parsley, collards, mustard greens, turnip greens, onions, water cress, etc.

TABLE 4.–TOTAL BETA RADIOACTIVITY IN SEA FOOD

Food item	Year	No. samples	Total beta dpm/gm
Oysters..................	1958	6	2.8
	1959	12	2.7
Clams....................	1958	14	1.4
	1959	24	1.5
Shrimp (canned)......	1958-1959	13	0.0
Salmon..................	1958	50	0.5
	1959	27	0.3
Tuna fish (canned)...	1958-1959	38	0.0

TABLE 5.—TOTAL BETA RADIOACTIVITY IN TEA

Areas of the world	Period when sampled	No. samples	Total beta dpm/gm
Africa[a]....	Aug.—Dec. 1958	20	8.5
	Jan.—June 1959	13	8.3
	July 1959—Jan. 1960	38	5.3
Brazil........	Aug.—Dec. 1958	37	11.7
	Jan.—June 1959	12	4.3
	July 1959—Jan. 1960	14	4.3
East Indies (b)	Aug.—Dec. 1958	89	10.7
	Jan.—June 1959	18	4.5
	July 1959—Jan. 1960	80	4.4
India[c]......	Aug.—Dec. 1958	89	23.6
	Jan.—June 1959	72	9.8
	July 1959—Jan. 1960	312	19.9
Japan (d)....	Aug.—Dec. 1958	170	48.8
	Jan.—June 1959	79	31.7
	July 1959—Jan. 1960	77	43.4

(a) Includes: Kenya, Belgian Congo, Tanganyika, Mozambique, Nyasaland, Portuguese E. Africa, and Uganda.
(b) Includes: Java, Sumatra, Indonesia, and Malaya.
(c) Includes: India, Ceylon, and Pakistan.
(d) Includes: Japan and Formosa.

STRONTIUM-90 CONCENTRATION IN FOOD SAMPLES TAKEN IN STATE OF ALASKA

The Lamont Geological Observatory of Columbia University at Palisades, N. Y., has conducted strontium-90 analyses of food samples from Alaska, collected in cooperation with the Public Health Service Arctic Health Research Center and the University of Alaska.

Table 1 presents the strontium-90 concentration in the food samples.*

At the beginning of the project, it was considered that the strontium-90 body burden of the average Alaskan might not be particularly high due to:

a. rather low rainfall so that the strontinum-90 is not washed out in proportion to its atmospheric concentration.

b. the fact that the major portion of the diet for urban areas is imported.

c. the extensive use of fish and other aquatic life in the native diet.

However, because some Eskimos subsist almost entirely on caribou meat, one might expect high strontium-90 body burdens among those persons.

While the data in table 1 are limited, several features are evident:

a. Stable foods from the Fairbanks area have approximately the same strontium-90 analyses as foods from other U. S. locations.

b. Marine life is characterized by low values of strontium-90 as shown by the assay of whale, seal, walrus, as well as that of the polar bear, which also lives on marine life. (There is an anomaly here with respect to one walrus meat sample which shows 360 μμc Sr^{90}/gm Ca.)

c. Fresh water fish have strontium-90 levels which are at least one order of magnitude greater than the marine life as indicated by both beluga and whitefish samples.

d. The only analysis of caribou meat shows a high value of strontium-90.

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*Data reported by Dr. A. R. Schulert, Lamont Geological Observatory, supported under a contract with AEC.

TABLE 1.—STRONTIUM-90 CONCENTRATION IN ALASKAN FOOD SAMPLES

Food	Location	Collection date	Strontium-90 content		
			dpm/kg wet	dpm/gm ash	μμc Sr^{90}/gm Ca
Wheat	Fairbanks	1957	22.0	1.42	22.6
Wheat	Fairbanks	1958	98.0	6.38	104.7
Wheat	Fairbanks	1959	106	6.20	125.1
Cabbage	Fairbanks	1959	5.94	1.11	7.8
Potatoes	Fairbanks	1959	1.62	0.17	7.8
Whale meat	Pt. Hope	Oct. '59	≤0.04	≤0.07	≤2.4
Whale rib (bowhead)	St. Lawrence	May '59	≤64	≤0.12	≤0.13
Seal backbone	Pt. Hope	Fall '59	8.40	0.07	0.08
Tom Cod	Pt. Hope	Dec. '59	3.45	0.05	0.10
Polar bear meat	Pt. Hope	Fall '59	≤0.6	≤0.06	≤2.8
Walrus backbone	St. Lawrence	Spring '59	324	0.65	0.77
Walrus meat	St. Lawrence	Spring '59	180	9.38	360
Needlefish	Hooper Bay	Oct. '59	605	7.24	7.57
Dried flounder plus herring	Newfok	Oct. '59	110	1.46	2.70
cod	Kotzebue	Oct. '59	362	6.63	7.85
Whitefish	Kobuk River	Oct. '59	156	2.26	15.7
Whitefish	Kobuk River	Spring '60	(2,390)*	42.4	62.4
Whitefish	Kobuk River	Spring '60	(115)*	2.03	3.54
Whitefish	Kobuk River	Spring '60	(1,410)*	25.0	32.8
Beluga meat	Kotzebue	Oct. '59	0.39	0.12	8.8
Beluga meat	Kotzebue	Fall '59	26.3	0.81	142.3
Beluga meat	Kotzebue	Oct. '59		0.67	11.5
Caribou meat	Anaktuvuk Pass	Nov. '59	16.0		160
Caribou antlers	Anaktuvuk River	Oct. '59	9,450	238	281
Caribou antlers	Anaktuvuk River	Oct. '59	6,480	146	170
Caribou antlers	Tolugak Creek	Oct. '59	6,400	143	170
Plant roots	Shungnak	Oct. '59	106	4.30	16.7
Caribou stomach contents	Anaktuvuk River	Nov. '59	7,880	245	1,264

*These values approximate, since accurate wet weights were not obtained on these samples.

STRONTIUM-90 IN FOOD

Health and Safety Laboratory
U. S. Atomic Energy Commission

The Health and Safety Laboratory has analyzed samples of vegetables from the Brawley, California area for calcium and strontium-90 content. The following table gives the values for samples collected at about yearly intervals since 1957. The data first appeared in Health and Safety Laboratory Report, HASL-90, dated August 18, 1960.

TABLE 1.–STRONTIUM-90 IN FOODS FROM BRAWLEY, CALIF.

Sampling period	Type food	gm Ca/kg wet weight	μμc Sr^{90}/kg wet weight	μμc Sr^{90}/gm Ca
February 1957........	Pea pods	0.52	<0.16	<0.3
	Broccoli	1.3	1.6	1.2
	Cantaloupe rinds and flesh	9.9*	<3.0	<0.3
	Cataloupe seeds	12.7*	<2.5	<0.2
January 1959	Lettuce..........................	0.35	2.4	6.8
	Broccoli..........................	1.0	2.4	2.4
	Cabbage..........................	-	1.8	-
December 1959.........	Lettuce..........................	0.28	1.9	6.8
	Broccoli..........................	0.63	1.3	2.0
	Cabbage..........................	0.44	2.2	5.1

*Dry weight.

STRONTIUM-90 CONTENT IN THE MILITARY DIET IN PERU AND ECUADOR (1959)[1]

Nutritional surveys on native military populations in South American countries conducted by the U. S. Interdepartmental Committee on Nutrition for National Defense have made available comprehensive information on diet and nutritional status of these groups of people. As a result of these surveys, composite diets have been made available to Lamont Geological Observatory of Columbia University to provide assessment of dietary ingestion of radionuclides as reflected in the strontium-90 content. Data presented herein are for the countries of Peru and Ecuador.

The average daily intake per person of strontium-90 for Peru is 2.81μμc. See table 1. This radionuclide concentration is roughly 18 percent of the value of 15.4μμc reported by Straub et al[2] in the diet of persons living in Cincinnati, Ohio.

Since fallout debris is washed out of the atmosphere by rain, correlations have been made between distribution of radionuclides in soil and foliar contamination on plants which is ultimately reflected in foodstuffs. In table 2, the relationship between rainfall and dietary concentration of strontium-90 (μμc per gram of calcium) is shown for various locations in Peru.

Since importation of foods from other countries may be involved in some instances, the relationship may be qualitative. The value for the city of Iquitos may be somewhat lower than expected despite the high rainfall, since the military at this base import large amounts of their food from other areas and consume only 20 percent of food grown locally.

The military establishments in Peru have a food supplement day, about every third day, at which time extra rations are provided principally in the form of fruit. The higher strontium-90 concentration in the diet on those days reflects this supplement which consists mainly of bananas and oranges. The Lamont analyses have shown that bananas have a particularly high strontium-90/calcium ratio.

In table 3, the strontium-90 content for the military diets in Ecuador for 1959 is shown for seven locations. The daily intake of strontium-90 is somewhat lower than that for Peru but the difference is not large. Of significance however is the fact that the contamination of foodstuffs with radioactivity in Ecuador is about 7 percent of that reported in the United States during 1959. Reference is made to table XII, "Estimate of Strontium-90 in United States Diets," Radiological Health Data, October 1960.

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[1] Reported to the U. S. Atomic Energy Commission by Dr. A. R. Schulert, Lamont Geological Observatory, Columbia University in Annual Report dated October 1, 1960. This study was performed through cooperative arrangement between the ICNND and AEC.

[2] Straub, C. P., G. K. Murthy, and J. E. Campbell, "Radionuclides in Foods"--a paper presented at the Annual meeting of the Ohio Dietetic Association, Cincinnati, Ohio, May 6, 1960.

TABLE 1.--STRONTIUM-90 CONTENT OF MILITARY DIET IN PERU (1959)

Location	Date	Strontium-90	
		μμc/person/day	μμc/gm Ca
Chorillos	February 24	3.21	2.25
	25	2.80	1.71
	26	4.16	*3.52
	Average...	3.39	2.49
Piura	April 9	4.28	1.43
	10	2.74	*2.74
	11	2.55	1.08
	Average...	3.19	1.75
Taena....	March 10	2.80	2.03
Tumbes	April 13	3.25	1.61
	14	2.89	2.22
	15	1.77	*3.76
	Average...	2.63	2.53
Arequipa	March 9	1.79	2.11
	10	2.29	3.33
	Average...	2.04	2.72
Puno......	March 16	2.55	3.51
Iquitos...	March 31	-	1.54
	April 1	-	1.75
	April 2	2.29	6.79
	Average...	2.29	3.36
Average daily intake..		2.81	2.63

*Supplement Day—extra food supplied, principally fruit.

TABLE 2.--RELATIONSHIP OF RAINFALL AND STRONTIUM-90 CONCENTRATION IN THE MILITARY DIET IN PERU (1959)

Location	Rainfall inches/year	Strontium-90 μμc/gm Ca
Chorillos	arid	2.49
Piura..............	arid	1.75
Taena	arid	2.03
Tumbes	40	2.53
Arequipa	40	2.72
Puno	60	3.51
Iquitos............	140	3.36
Average........	....	2.63

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TABLE 3.—STRONTIUM-90 CONTENT IN MILITARY DIETS IN ECUADOR (1959)

Location	Date	Strontium-90	
		μμc/person/day	μμc/gm Ca
Loja......	July-August	2.68	3.95
Cuenca..	July-August	0.52	1.02
Tulcan ..	July-August	1.02	2.82
Quito	July-August	0.59	1.23
Guayoquil	July-August	1.00	1.54
Salinos...	July-August	1.04	3.00
Machale..	July-August	1.44	3.71
Average	....	1.18	2.47

STRONTIUM-90 CONTENT IN THE MILITARY DIET IN VIETNAM (1959)[1]

The U. S. Interdepartmental Committee on Nutrition for National Defense has conducted a nutrition survey of the native military population in Vietnam at ten locations to provide information on dietary intakes and nutritional status. In table 1 are presented values on the strontium-90 content of the composite diet collected during the fall months of 1959. The dietary intake of strontium-90 for Vietnam is considerably higher than that reported for the South American countries of Peru and Ecuador (see previous article, page 23). The Vietnam values approach those for the diet of persons living in Cincinnati, Ohio, (average value of Vietnam 8.3 μμc/person/day as compared to 15.4 μμc/person/day in the PHS Cincinnati study as reported in Radiological Health Data, October 1960).

The higher value for Vietnam as compared to Ecuador and Peru is partially the result of larger concentrations of fallout radionuclides. Vietnam lies in the Northern Hemisphere (10-20°N) while Educdor (2°N-4°S) and Lima (4°S-19°S) are primarily in the Southern Hemisphere; consequently, the latter have been subjected to considerably less fallout. A significant and perhaps major factor is the dietary difference between these countries. The rice component of the diet is quite high in Vietnam. The unhulled kernel of rice, as is true in the case of the wheat kernel in the U. S. A., reflects a rather higher concentration of strontium-90 value. This is shown in the value for rice polishings in table 2 of the Vietnam data. The contribution of strontium-90 content in cereal products in Asiatic countries where large amounts of rice are consumed has perhaps a more significant contribution to total diet than that experienced from ingestion of wheat milling products in other countries.

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[1] Reported to the U. S. Atomic Energy Commission by Dr. A. R. Schulert, Lamont Geological Observatory, Columbia University in Annual Report dated October 1, 1960. This study was performed through cooperative arrangement between the ICCND and AEC.

TABLE 1.—STRONTIUM-90 CONTENT IN MILITARY DIETS IN VIETNAM (1959)

Location	Date	Strontium-90	
		μμc/day	μμc/gm Ca
Bien Hoa	October 30	5.7	3.5
Dalat	November 16	7.0	10.3
Danang	November 23	19.9	17.0
Duc My	November 11	4.3	13.8
Ho Nai (civilian)	November 6	9.4	6.4
Kontum	November 16	8.5	10.4
Nha Trang	November 9	2.3	7.5
Phong Dinh	December 2	6.3	7.0
Quang Trung*	October 28	2.7	4.4
Quang Trung**	October 29	16.7	13.3
Average daily intake		8.3	9.4

*Polished rice.
**Unpolished rice.

TABLE 2.--STRONTIUM-90 CONTENT IN INDIVIDUAL FOODS OF VIETNAM

(November-December 1959)

Food	Strontium-90 μμc/gm Ca
Rice components—Saigon area:	
Samples from same plot at threshing:	
Total unhulled kernel	26.1
Stalks	47.2
Samples from same mill run:	
Finished polished rice	6.6
Polishings	52.0
Water cress:	
At Dalat	8.4
At Danang	27.4

STRONTIUM-90 CONTENT IN DIET IN VARIOUS COUNTRIES

The following table presents the average daily strontium-90 intake per person in various countries. It must be kept in mind that these are estimates made by the groups noted below. The guide for average daily intake of strontium-90 used by the Department of Health, Education, and Welfare is presently 33 micromicrocuries per kilogram of total dietary intake averaged over a period of one year. In the United States the daily per capita consumption is about 2.2 kilograms. The daily guide for the United States is therefore about 73 μμc of strontium-90.

TABLE 1.--STRONTIUM-90 CONTENT IN DIET IN VARIOUS COUNTRIES (1959)

Country	Strontium-90	
	μμc/day	μμc/gm Ca
Ecuador[a]	1.2	2.5
England[b]	9.8	9.0
Germany[c]	13.0	11.5
Japan[d]	7.8	13.4
Peru[a]	2.8	2.6
United States (Cincinnati, Ohio[e])	15.4	14.0
Vietnam[a]	8.3	9.4

[a] Annual Report to Atomic Energy Commission by Lamont Geological Observatory, Columbia University, Palisades, N. Y., October 1, 1960.

[b] Strontium-90 in Human Diet in United Kingdom--1959. Agricultural Research Council Radiobiological Laboratory.

[c] Report to U. N. Scientific Committee on the Effects of Atomic Radiation. "The Strontium-90 Content of the Diet of Children and Juveniles in 1950" by D. Merten and F. Knopp--Bad Godesberg, Germany--Report II C--6930-1, 14/60 July 20, 1960.

[d] Report of Japanese Government (University of Tokyo) by Yoshio Hiyama, "Annual and Geographical Change of Strontium-90 Dietary Intake of Japanese" (1957-60).

[e] Straub, C. P., G. K. Murthy, and J. E. Campbell, "Radionuclides in Foods"--a paper presented at the Annual Meeting of the Ohio Dietetic Association, Cincinnati, Ohio, May 6, 1960. See also table XII, Estimates of Strontium-90 in United States Diets, Radiological Health Data, October 1960.

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SECTION III.—MILK

PUBLIC HEALTH SERVICE MILK MONITORING PROGRAM

The original Public Health Service Milk Monitoring Program consisted of 12 sampling stations. This is being expanded to include an additional 60 stations, of which 58 submitted samples for August. Since the sampling procedures for the original and the added stations are somewhat different, they will be described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Alabama, and the Southwestern Radiological Health Laboratory at Las Vegas, Nevada, provide this service for the added stations.

Publication of the data will normally follow about four months after collection of samples because of the time required for shipment, processing, decay product build-up, compilation of the data, clearance and publication procedures.

Original Stations

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Department of Health, Education, and Welfare to determine trends in our changing environment, including measurement of amounts of radioactivity in water, air, milk, and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop and simplify methods of collection and radiochemical analysis of milk to make them more suitable for larger scale programs. Since this program has been in operation for over three years, its contribution of information is significant.

Selection of the original sampling stations was based on the following criteria:

1. The milk represented in each sample was from a group of farms milking a total of at least 1,000 cows.
2. The number of individual farms was small enough so that collection of collateral field data from each farm was feasible.
3. The milk samples were from a supply that was part of a metropolitan milkshed.
4. The conditions under which the milk was received were such that each sample was representative of the same farms in the production area.

The Overton, Nevada and St. George, Utah milksheds do not fulfill the 1,000-cow minimum requirement but have been included because they are part of the monitoring program around the Nevada Test Site.

One-gallon samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analysis. It is estimated that these samples represent 2,000-gallon lots. The concentration of iodine-131, barium-140, and cesium-137 and naturally occurring potassium-40 are all currently being measured, when present in the milk, by gamma scintillation spectroscopy. Total strontium and strontium-90 are determined following radiochemical separations, the strontium-90 being calculated by measuring the build-up in a two-week period of the daughter decay product, yttrium-90, using a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter with the strontium-89 calculated as the difference.

A description of the program appears in "The Occurrence of Strontium-90, Iodine-131 and Other Radionuclides in Milk, May 1957 through April 1958," by J. E. Campbell, G. K. Murthy, A. S. Goldin, H. B. Robinson, C. P. Straub, F. J. Weber, and K. H. Lewis, American Journal of Public Health, Vol. 49, No. 2, pp. 225-235, Feb. 1959.

April through September 1960 issues of Radiological Health Data list references for technical descriptions of the methodology of analyses used.

August data for the original stations are presented in table 1.

Added Stations

The Milk Monitoring Program has been expanded to provide additional information on levels of radioactivity in milk consumed by the public. The new stations are being established in cooperation with State and local health and milk sanitation agencies. The cities have been selected in order to provide adequate coverage from the combined viewpoints of production areas and consuming population. The emphasis on this expanded sampling and radioassay program is that of:

1. Measuring the radioactivity levels of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the point of distribution to the public.

2. Providing one sampling point within each state with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of larger population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving the milk production and milkshed area characteristics.

In some instances the designated points are the same as those which reported originally. The establishment of the added sampling stations does not preclude the need for further samples from the selected milksheds serving the same cities. It is important that both networks be in operation for a sufficient period of time to provide an overlap for purposes of comparative study.

The sampling procedure has been developed to give a sample from one day's sales per month in a community which will be as representative of the total supply as can be achieved under practical conditions. The sample will be a composite of those plants supplying not less than 90 percent of the city's milk supply. The contribution from each plant to the total sample will be approximately proportional to volume of milk sold.

The samples from the added stations are collected with the assistance of the various State and local health and milk sanitation agencies and shipped for analysis to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples from the 30 states generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the western states

At the present time radioassays for Sr^{89}, Sr^{90} and Cs^{137} are being performed. Other radionuclides of concern to public health agencies will be included for assay as necessary for complete monitoring of the milk supply.

Data from the Southwestern Radiological Health Laboratory and the Southeastern Radiological Health Laboratory for August 1960 are presented in table 2.

TABLE 1.—RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program
Robert A. Taft Sanitary Engineering Center

August 1960

(Radioactivity in μμc/liter)

Area	Calcium grams/liter		Iodine-131		Strontium-89		Strontium-90		Barium-140		Cesium-137	
	Au-gust	Yearly average	Au-gust	Yearly average	Au-gust	Yearly average	Au-gust	Yearly average	Au-gust	Yearly average	Au-gust	Yearly average
Atlanta, Georgia	1.06	1.12	ND	<10	ND	<5	13	15	ND	<10	20	48
Austin, Texas	1.05	1.09	ND	<10	ND	<5	3	5	ND	<10	15	21
Chicago, Illinois	1.01	1.09	ND	<10	ND	<5	8	9	ND	<10	15	36
Cincinnati, Ohio	1.06	1.12	ND	<10	ND	<5	10	11	ND	<10	10	28
New York, New York	1.04	1.07	ND	<10	ND	<5	8	9	ND	<10	10	32
Sacramento, Calif.	1.09	1.09	ND	<10	ND	<5	4	4	ND	<10	5	14
Salt Lake City, Utah	1.06	1.10	ND	<10	ND	<5	5	7	ND	<10	10	35
Spokane, Washington	1.10	1.11	ND	<10	ND	<5	9	12	ND	<10	25	49
St. Louis, Missouri	1.10	1.23	ND	<10	ND	<5	16	20	ND	<10	10	37

Samples are taken at one sampling point from the milk supply of the areas listed above.
ND—No detectable activity.

TABLE 2.--RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program

Added Stations--August 1960

(Radioactivity in μμc/liter)

Area	Calcium grams/liter		Strontium-89		Strontium-90		Cesium-137	
	August	Average to date[1]	August	Average to date[1]	August	Average to date[1]	August	Average to date[1]
Atlanta, Ga.	1.20	1.20	ND	<5	11	11	<10	<10
Albuquerque, N. M.	1.05	1.14	ND	<5	3	4	-	-
Austin, Tex.	1.16	1.12	ND	<5	1	2	<10	10
Baltimore, Md.	0.97	0.97	ND	<5	6	6	<10	<10
Boston, Mass.	1.19	1.16	ND	<5	10	14	20	30
Buffalo, N. Y.	1.10	1.21	ND	<5	6	7	<10	10
Burlington, Vt.	1.18	1.17	ND	<5	7	10	<10	20
Charleston, S. C.	1.20	1.20	ND	<5	10	10	20	20
Charleston, W. Va.	-	1.16	ND	<5	8	10	<10	10
Charlotte, N. C.	1.22	1.17	ND	<5	5	12	<10	10
Chicago, Ill.	1.08	1.06	ND	<5	6	7	<10	<10
Cincinnati, Ohio	1.14	1.14	ND	<5	9	9	<10	<10
Cleveland, Ohio	1.18	1.06	ND	<5	8	8	10	<10
Dallas, Tex.	1.19	1.23	ND	<5	5	6	<10	<10
Denver, Colo.	1.03	1.14	ND	<5	5	7	-	-
Detroit, Mich.	1.19	1.10	ND	<5	6	7	<10	<10
Des Moines, Iowa	0.98	1.06	ND	<5	7	8	-	20
Grand Rapids, Mich.	-	1.18	ND	<5	6	8	<10	<10
Hartford, Conn.	1.16	1.15	ND	<5	10	9	10	20
Helena, Mont.	1.08	1.08	ND	<5	4	6	-	25
Honolulu, Hawaii	1.06	1.06	ND	<5	6	4	-	40
Idaho Falls, Idaho	0.98	1.07	ND	<5	3	5	-	40
Indianapolis, Ind.	1.18	1.14	ND	<5	6	6	<10	<10
Jackson, Miss.	1.23	1.23	ND	<5	14	14	<10	<10
Kansas City, Mo.	1.07	1.10	ND	5	6	8	-	-
Laramie, Wyo.	1.04	1.07	ND	<5	6	5	-	-
Las Vegas, Nev.	1.02	1.09	ND	<5	2	3	-	-
Little Rock, Ark.	1.20	1.20	ND	<5	10	10	<10	<10
Louisville, Ky.	1.21	1.18	ND	<5	10	8	10	<10
Manchester, N. H.	1.18	1.22	ND	<5	10	13	30	40
Milwaukee, Wis.	1.20	1.13	ND	<5	4	6	<10	<10
Minneapolis, Minn.	0.95	0.95	ND	<5	10	10	-	-
New Orleans, La.	1.28	1.16	ND	<5	14	16	<10	10
New York, N. Y.	1.10	1.10	ND	<5	8	10	<10	10
Norfolk, Va.	1.20	1.14	ND	<5	10	10	<10	<10
Oklahoma City, Okla.	1.17	1.14	ND	<5	8	8	<10	<10
Omaha, Nebr.	1.05	1.05	ND	<5	9	9	-	-
Palmer, Alaska	1.01	1.08	ND	<5	8	7	-	30
Philadelphia, Pa.	1.07	1.13	ND	<5	10	10	<10	20
Phoenix, Ariz.	1.00	1.01	ND	<5	4	4	-	15
Pittsburgh, Pa.	-	1.23	ND	<5	10	14	<10	20
Portland, Maine	1.14	1.12	ND	<5	10	14	30	35
Portland, Oreg.	1.04	1.09	ND	5	10	11	-	70
Providence, R. I.	1.18	1.15	ND	<5	11	14	10	20
Sacramento, Calif.	1.04	1.04	ND	<5	3	3	-	-
Salt Lake City, Utah	1.08	1.11	ND	<5	4	6	-	-
San Francisco, Calif.	1.07	1.09	ND	<5	3	5	-	20
San Juan, P. R.	1.15	1.10	ND	<5	4	4	<10	<10
Seattle, Wash.	1.04	1.09	ND	5	8	9	-	60

See footnotes at end of table.

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TABLE 2.--RADIOACTIVITY IN MILK--Con.

Public Health Service Milk Monitoring Program

Added Stations--August 1960

(Radioactivity in μμc/liter)

Area	Calcium grams/liter		Strontium-89		Strontium-90		Cesium-137	
	August	Average to date[1]	August	Average to date[1]	August	Average to date[1]	August	Average to date[1]
Spokane, Wash.	1.04	1.08	ND	<5	5	8	-	-
St. George, Utah	0.95	0.95	ND	<5	5	5	-	-
St. Louis, Mo.	0.98	0.96	ND	<5	6	6	-	-
Syracuse, N. Y.	1.14	1.23	ND	<5	6	7	20	20
Tampa, Fla.	1.22	1.22	ND	<5	4	4	80	80
Trenton, N. J.	1.14	1.17	ND	<5	7	8	<10	10
Washington, D. C.	1.15	1.10	ND	<5	8	9	<10	10
Wichita, Kansas	0.98	1.08	ND	<5	7	6	-	-
Wilmington, Del.	1.37	1.21	ND	<5	7	9	<10	20

ND--No detectable activity.

[1] Because this program was initiated in 1960 and sampling stations necessarily become operative in a staggered sequence, the averages shown represent all samples taken to date. Averages will normally be for the latest 12 month period after sampling began. For the August data, the average covers a period of one to six months.

STRONTIUM-90 IN NORTH AMERICAN MILK

Lamont Geological Observatory
Columbia University

As a part of its contract with the Atomic Energy Commission, the Lamont Geological Observatory has continued its study of the concentration of strontium-90 in milk. The Los Alamos Scientific Laboratory's powdered milk program for cesium-137 determinations provides milk samples to Lamont for strontium-90 analysis. Additional samples are obtained by the Lamont group.

The following table presents a summary of averages of strontium-90 in North American Milk. Results of analyses conducted by the Public Health Service, Consumers Union and Health and Safety Laboratory, Atomic Energy Commission, are also included in this tabulation.

TABLE 1.--SUMMARY OF AVERAGES OF STRONTIUM-90 IN NORTH AMERICAN MILK

(μμc/gm calcium)

Area	1957	1958	1959	1960*
Eastern U. S. (40-60 inches rainfall)	6.5	8.7	11.2	9.4
Central States, Eastern Canada (20-40 in. rainfall)	6.4	7.5	9.2	9.8
Great Plains States (10-30 in. rainfall)	6.1	8.7	11.4	8.1
Desert Areas (5-15 in. rainfall)	2.5	3.4	6.0	3.0
Northwest Coast (30-60 in. rainfall)	4.6	6.8	11.7	8.6
U. S.-Canada Average--weighted for population	6.2	8.1	10.7	∿ 7

*First half of 1960.

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CESIUM-137 IN PEOPLE AND MILK IN THE UNITED STATES

Los Alamos Scientific Laboratory
U. S. Atomic Energy Commission

Studies of cesium-137 in people and milk performed by the Los Alamos Scientific Laboratory during 1959 and early 1960 were reported previously.[1] Data have now been reported for April—August 1960.[2] Extreme values observed during this period are summarized below.

TABLE 1.—CESIUM-137 IN PEOPLE AND MILK IN THE U. S.

(Concentrations in uuc Cs^{137}/gm potassium)

Samples	Late 1959-early 1960	April-August 1960
Highest Cs^{137} in milk......	114	84
Lowest Cs^{137} in milk.......	5	0.03
Highest Cs^{137} in people....	113	150
Lowest Cs^{137} in people....	42	10

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[1] AEC Health and Safety Laboratory Reports, HASL-77, HASL-88, and summarized in Radiological Health Data, October 1960.

[2] AEC Health and Safety Laboratory Report, HASL-95, October 1, 1960.

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SECTION IV.—WATER

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK

The National Water Quality Network was established under the provision of Section 4 (c) of Public Law 660, which states "...The Surgeon General shall ... collect and disseminate basic data ... (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local health agencies, was started in October 1957. At present there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses; some of these stations are interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately a total of 250 to 300 stations will be operated. A few of the more recently established stations have not yet begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The radioactivity levels of dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the same nuclides being present. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River. The results are reported in micromicrocuries per liter, and are shown for each station on a given river.

While beta determinations for the first two years of the Network operation have been done on each sample weekly, the alpha determinations are reported generally on a composite sample of more than one week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on three-month composite samples, with 1/3 of the stations being covered each month. All the data reported below represent the average of all information available for the month indicated.

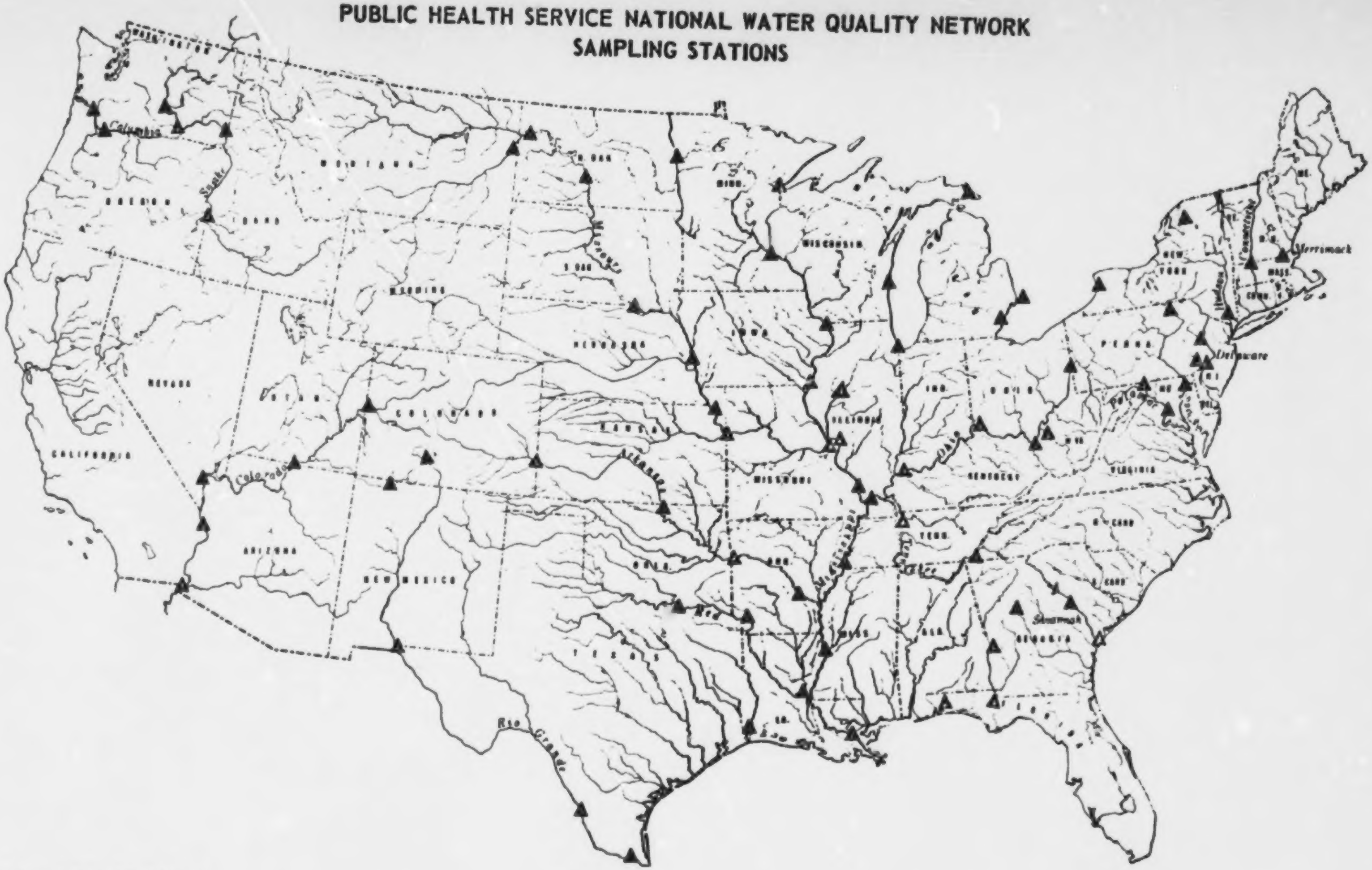
Strontium-90 data are reported as being the results of determinations on composite samples for a three-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

1. "National Water Quality Network Annual Compilation of Data," PHS Publication. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.50.

2. "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, to Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167-169.

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK
SAMPLING STATIONS



WASHINGTON
Columbia
Snake
OREGON
IDAHO
MONTANA
WYOMING
NEVADA
UTAH
COLORADO
CALIFORNIA
Colorado
ARIZONA
NEW MEXICO
Rio Grande
TEXAS
Missouri
NEBRASKA
KANSAS
Arkansas
OKLA.
Red
MINN.
WISCONSIN
IOWA
MISSOURI
ILLINOIS
Mississippi
ARK.
LA.
MISS.
TENN.
Tennessee
Ohio
OHIO
KENTUCKY
ALA.
GEORGIA
Savannah
VIRGINIA
Potomac
PENNA.
NEW YORK
Delaware
Hudson
Connecticut
Merrimack
MASS.
CONN.
ME.

As of June 30, 1960

FIGURE 1

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TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS
Public Health Service National Water Quality Network
(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	July 1960					
		Beta activity			Alpha activity		
	Strontium-90	Susp.	Diss.	Total	Susp.	Diss.	Total
ANIMAS RIVER							
Cedar Hill, N. Mex.	0.3	2	9	11	1	11	12
ARKANSAS RIVER							
Coolidge, Kans.	1.1	-	-	-	-	-	-
Ponca City, Okla.	1.3	0	14	14	3	7	10
Fort Smith, Ark.	1.1	85	<1	86	-	-	-
Pendleton Ferry, Ark.	1.2	57	3	60	0	0	0
CHATTAHOOCHIE RIVER							
Atlanta, Ga.	(*)	0	<1	<1	0	0	0
Columbus, Ga.	0.5	0	0	0	3	0	3
COLORADO RIVER							
Loma, Colo.	0.3	0	0	0	1	13	14
Page, Ariz.	0.9	30	18	48	19	10	29
Hoover Dam, Ariz.-Nev.	1.3	0	1	1	0	9	9
Parker Dam, Ariz.-Calif.	0.4	-	-	-	-	-	-
Yuma, Ariz.	1.0	0	<1	<1	0	6	6
COLUMBIA RIVER							
Pasco, Wash.	0.3	16	98	114	0	<1	<1
Wenatchee, Wash.	0.3	0	0	0	0	0	0
Bonneville Dam, Ore.	(*)	18	158	176	-	-	-
Clatskanie, Ore.	0.3	-	-	-	-	-	-
DELAWARE RIVER							
Martin's Creek, Pa.	0.4	0	0	0	-	-	-
Philadelphia, Pa.	0.3	0	0	0	4	0	4
GREAT LAKES							
Gary, Ind.	(*)	0	0	0	0	0	0
Duluth, Minn.	0.3	0	0	0	0	0	0
Detroit, Mich.	0.6	<1	0	<1	0	0	0
Buffalo, N. Y.	0.7	0	12	12	-	-	-
HUDSON RIVER							
Poughkeepsie, N. Y.	0.7	0	4	4	-	-	-
ILLINOIS RIVER							
Peoria, Ill.	0.8	2	2	4	1	2	3
KANAWHA RIVER							
Winfield Dam, W. Va.	0.3	0	0	0	0	<1	<1
MISSISSIPPI RIVER							
Red Wing, Minn.	1.5	0	1	1	-	-	-
Dubuque, Iowa	(*)	1	5	6	<1	<1	1

*Insufficient sample for analysis.

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TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Con.

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	July 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
MISSISSIPPI RIVER—Con.							
East St. Louis, Ill.	1.2	2	8	10	5	0	5
Cape Girardeau, Mo.	0.9	4	4	8	-	-	-
West Memphis, Ark.	0.9	0	2	2	5	1	6
Delta, La.	(*)	0	0	0	-	-	-
New Orleans, La.	1.0	7	5	12	3	1	4
MISSOURI RIVER							
Williston, N. D.	0.7	2	15	17	2	4	6
Bismarck, N. D.	0.9	-	-	-	-	-	-
Yankton, S. D.	1.0	0	8	8	6	3	9
Omaha, Nebr.	0.6	4	<1	4	6	4	10
St. Joseph, Mo.	0.9	75	16	91	-	-	-
Kansas City, Kans.	0.9	86	24	110	-	-	-
St. Louis, Mo.	1.0	45	35	80	6	3	9
OHIO RIVER							
East Liverpool, O.	1.9	0	1	1	0	0	0
Wheeling, W. Va.	-	<1	<1	1	<1	0	<1
Huntington, W. Va.	0.3	0	12	12	0	0	0
Cincinnati, O.	0.6	5	27	32	4	0	4
Evansville, Ind.	0.4	8	0	8	7	0	7
Cairo, Ill.	0.7	6	4	10	3	4	7
POTOMAC RIVER							
Williamsport, Md.	0.8	0	1	1	-	-	-
Great Falls, Md.	0.5	0	0	0	-	-	-
RED RIVER							
Denison, Tex.	1.2	0	0	0	1	0	1
Index, Ark.	1.2	0	44	44	-	-	-
Alexandria, La.	0.7	-	-	-	-	-	-
RIO GRANDE RIVER							
El Paso, Tex.	1.4	0	0	0	<1	2	2
Laredo, Tex.	1.0	112	59	171	59	1	60
Brownsville, Tex.	0.7	0	0	0	<1	2	2
SABINE RIVER							
Ruliff, Tex.	(*)	2	1	3	1	0	1
ST. CLAIR RIVER							
Port Huron, Mich.	(*)	0	5	5	0	0	0
ST. LAWRENCE RIVER							
Massena, N. Y.	0.6	0	2	2	0	<1	<1
ST. MARY'S RIVER							
Sault Ste. Marie, Mich.	0.4	2	0	2	0	0	0

*Insufficient sample for analysis.

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TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Con.

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	July 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
SCHUYLKILL RIVER							
Philadelphia, Pa.	0.7	0	0	0	0	0	0
SAVANNAH RIVER							
North Augusta, S. C.	(*)	0	1	1	-	-	-
Port Wentworth, Ga.	0.8	1	6	7	0	0	0
SNAKE RIVER							
Wawawai, Wash.	0.3	0	0	0	-	-	-
Weiser, Idaho	0.5	0	4	4	0	2	2
SUSQUEHANNA RIVER							
Sayre, Pa.	0.4	0	0	0	<1	0	<1
Conowingo, Md.	0.2	0	8	8	0	0	0
TENNESSEE RIVER							
Chattanooga, Tenn.	1.3	0	54	54	0	0	0
YELLOWSTONE RIVER							
Sidney, Mont.	0.3	4	6	10	1	2	3

*Insufficient sample for analysis.

MONITORING OF WATER SUPPLIES AROUND THE NEVADA TEST SITE

By contract with the Atomic Energy Commission the Public Health Service has conducted an off-site monitoring program around the Nevada Test Site since 1955. Included in the program have been measurements of radioactivity in water supplies. These data have been reported in the Atomic Energy Commission's 13th, 14th, 18th and 23rd Semiannual Reports to Congress and by the Public Health Service in the 1957 Congressional Hearings, "The Nature of Radioactive Fallout and Its Effects on Man."

Figure 1 summarizes the data on radioactivity (gross beta) in water supplies for the two-month period, July-August 1960.

The lower limit of detectability with the equipment used is about 10 micromicrocuries per liter.

TABLE 1.–DESCRIPTION OF WATER SAMPLING POINTS

Nevada Test Site

Location	Source	Population served
Las Vegas	13 wells--650 to 1,250' depth plus Lake Mead supply.	40,000
Game Reserve	400' drilled well	20
Indian Springs	600' drilled well	Average 250
Pahrump	75' driven well	10-50
Ash Meadows	Spring 25' deep	8
Lathrop Wells	3 wells--600' deep	Average 15
Beatty	Spring	550
Lida Junction	125' drilled well	2-10
Goldfield	Spring	Average 200
Tonapah	2 drilled wells–60' depth	Average 1,500
Warm Springs	Multiple springs--no improvement	10
Diablo	Well	State Highway Station
Lincoln Mine	2 driven wells	3
Caliente	Springs	Average 10-12
Crystal Springs	Free flowing spring	0
Alamo	2 wells--50-67' deep	Average 175
Pahranagat Lake	Surface	Not used for domestic purposes
Butler Ranch	Flowing spring	1
Warm Spring Ranch	Flowing spring from earth fault	Public park with swimming pool
Logandale	Drilled well	300
Ballistic Range	Drilled well	10-15

GROSS BETA MEASUREMENTS IN WATER SUPPLIES IN OFF-SITE AREAS OF THE NEVADA TEST SITE FOR July-August 1960

(μμc/liter at count time)

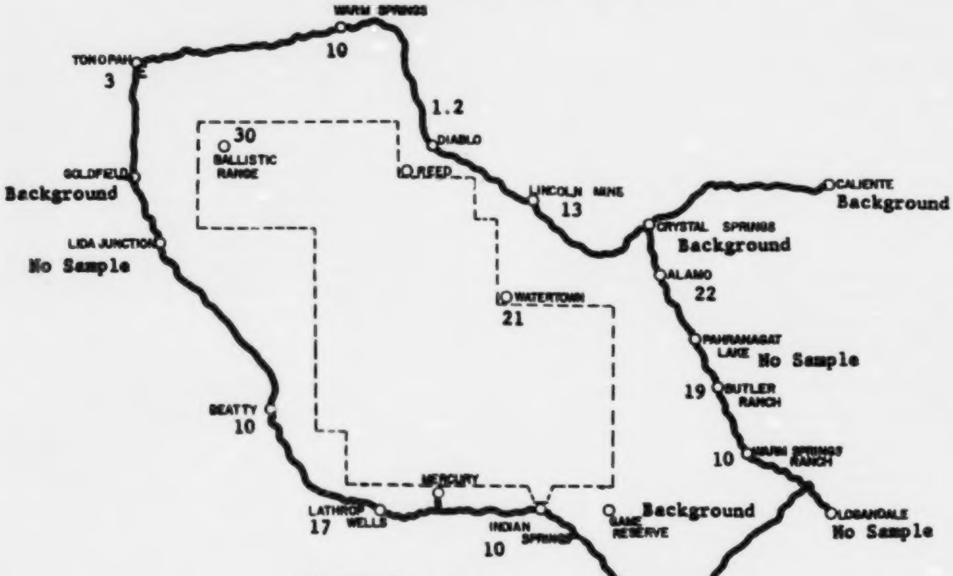
WARM SPRINGS
10
TONOPAH
3
1.2
DIABLO
30
BALLISTIC RANGE
REED
GOLDFIELD
Background
LINCOLN MINE
13
CALIENTE
Background
CRYSTAL SPRINGS
Background
LIDA JUNCTION
No Sample
ALAMO
22
WATERTOWN
21
PAHRANAGAT LAKE
No Sample
19
BUTLER RANCH
BEATTY
10
10
WARM SPRINGS RANCH
MERCURY
LATHROP WELLS
17
GAME RESERVE
Background
LOGANDALE
No Sample
INDIAN SPRINGS
10
ASH MEADOWS
16
PAHRUMP
17
LAS VEGAS
11

FIGURE 1

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SECTION V.—OTHER DATA

EXTERNAL GAMMA ACTIVITY

Public Health Service Radiation Surveillance Network

Portable survey instruments are available at the stations of the Radiation Surveillance Network and one of their uses is to record external gamma radiation. These readings are not precise, especially for measurement of low levels but they can show the presence or absence of any significant increases above background. The differences among the values shown on the following table are within the variance anticipated due to differences in normal background and in instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY

Public Health Service Radiation Surveillance Network

August 1960

Station location	Average* mr/hr	Station location	Average* mr/hr
Alaska, Anchorage	0.01	Mississippi, Pascagoula	(**)
Alaska, Fairbanks	(**)	Missouri, Jefferson City	0.01
Alaska, Juneau	0.02	Montana, Helena	0.03
Arizona, Phoenix	0.01	New Jersey, Trenton	0.02
Arkansas, Little Rock	0.02	New Mexico, Santa Fe	0.04
California, Berkeley	0.01	New York, Albany	0.02
California, Los Angeles	0.01	North Carolina, Gastonia	0.02
Colorado, Denver	0.02	Ohio, Cincinnati	(**)
Connecticut, Hartford	0.01	Oklahoma, Oklahoma City	0.02
District of Columbia	0.02	Oklahoma, Ponca City	0.04
Florida, Jacksonville	0.02	Oregon, Portland	0.01
Georgia, Atlanta	0.02	Pennsylvania, Harrisburg	0.01
Hawaii, Honolulu	0.02	Rhode Island, Providence	0.02
Idaho, Boise	0.02	South Carolina, Columbia	0.02
Illinois, Springfield	0.01	South Dakota, Edgemont	(**)
Indiana, Indianapolis	0.01	South Dakota, Pierre	0.02
Iowa, Iowa City	0.02	Texas, Austin	0.01
Kansas, Topeka	0.02	Texas, El Paso	0.02
Louisiana, New Orleans	0.01	Utah, Salt Lake City	0.02
Maryland, Baltimore	0.02	Virginia, Richmond	0.01
Massachusetts, Lawrence	0.02	Washington, Seattle	0.02
Michigan, Lansing	0.02	Wyoming, Cheyenne	0.02
Minnesota, Minneapolis	0.01		

*Readings taken 3 feet above ground.
No data received.

ARGONNE NATIONAL LABORATORY SOIL DATA

U. S. Atomic Energy Commission

Fission product radioactivity at the Argonne National Laboratory, Lemont, Illinois for July and August, 1960 has been reported by Dr. Philip F. Gustafson. Previous data were reported in the July and December 1960 Radiological Health Data.

Isotope	July 1960 mc/mi^2	August 1960 mc/mi^2
Zr^{95} Nb^{95}	30	0
Cs^{137}	183	174
Ru^{106}	790	740
Ce^{144}	1,160	1,150
Totals	2,163	2,064
Dose-rate (urads/hr)*	1.53	1.28

*Calculated dose-rate at one meter above ground surface. No correction is made for shielding effect of structures.

STRONTIUM-90 CONCENTRATION IN HUMAN BONE FROM ALASKA[1]

Strontium-90 analyses of Eskimo and Indian bone samples collected in Alaska, are conducted by Columbia University's Lamont Geological Observatory, Palisades, N. Y. The samples were obtained through the cooperation of the Public Health Service Hospital at Anchorage.

Only one of the first six samples analysed—bones from a Fort Yukon Indian—showed a lower strontium-90 content than the world average. Wide fluctuations in the bone content of strontium-90 among these people are anticipated because of the extreme fluctuations of strontium-90 concentrations in the native diet (see Table 1, page 30 for strontium-90 concentrations in Alaskan food samples).

Table 1 shows the concentrations of strontium-90 in human bone samples from this area which have been analyzed to date.

TABLE 1.—STRONTIUM-90 CONCENTRATION IN ALASKAN BONE SAMPLES

December 1959—May 1960

Age	Sex	Race	μμc/gm Ca
4 months	M	Eskimo	2.42
7 years	M	Eskimo	3.35
25 years	M	Indian	0.18
26 years	F	Eskimo	1.94
53 years	M	Eskimo	0.47
61 years	M	Indian	0.59

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[1] Reported to the U. S. Atomic Energy Commission by Dr. A. R. Schulert, Lamont Geological Observatory, Columbia University in "Annual Report" dated October 1, 1960.

STRONTIUM-90 ACTIVITY IN HUMAN BONE

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Lamont Geological Observatorv. Columbia University

Under contract with the Atomic Energy Commission the Lamont Geological Observatory has continued its program to study the concentration of strontium-90 in human bone.[1] New data have recently been reported. Past studies of this group have been published in the AEC Quarterly Statement on Fallout, January, 1960 and Radiological Health Data, May and July, 1960. A summary of human bone data for the period 1958-59 is presented below. Information on the specific bone examined is not available.

TABLE 1.--SUMMARY OF HUMAN BONE DATA 1958-59

($\mu\mu c\ Sr^{90}/gm\ Ca$)

Age-Years	Area				
	Africa	Asia	Europe	No. America	So. America
Fetus.............	-	0.47(1)*	-	<0.3-2.2(91)	-
0-4	-	-	<0.4(1)	<0.4-3.35(6)	<0.09-1.7(36)
5-9	0.3-<0.5(2)	-	1.02-1.32(2)	<0.3-<0.4(2)	<0.2-0.32(6)
10-19..............	<0.1-0.56(10)	0.95(1)	-	<0.2-3.7(16)	<0.1-1.0(26)
Adults.............	<0.1-0.37(2)	<0.07-0.86(8)	0.12-0.19(5)	0.3-1.94(17)	<0.05-0.36(10)

*The number of samples in each group is shown in parenthesis.

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The United States Atomic Energy Commission provides data on the environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis.

The November and December 1960 issues of Radiological Health Data summarized the 1959 and the first quarter reports for 1960 for fifteen installations. Second quarter 1960 reports for four of these installations are included in the following section.

BETTIS ATOMIC POWER LABORATORY

Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

September 1, 1960

Environmental levels of radioactivity at the Bettis Atomic Power Laboratory for 1959 and first quarter of 1960 were reported in the November 1960 issue of the Radiological Health Data. The following report presents the data for the second quarter of 1960.

The Bettis Atomic Power Laboratory (BAPL), operated for the Atomic Energy Commission (AEC) by the Westinghouse Electric Corporation, was established in 1949 and since that time has been engaged in research and development work related to naval atomic propulsion systems and the central station atomic power reactor at Shippingport.

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[1] Annual Report to the AEC, "Deposition of Neclear Fallout Debris," A. R. Schulert, et al, Lamont Geological Observatory, Columbia University, Palisades, New York, October 1, 1960.

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The data in this report indicates the levels of environmental radioactivity measured at the environs of BAPL. Figures 1 and 2 show the location of the laboratory in relation to the surrounding community and the locations at which the various kinds of environmental samples are collected.

Measurements are made continually to insure that controls on laboratory processes are adequate to prevent the release of radioactive materials to the surrounding community. Measurements are also made continually in the area surrounding the laboratory to determine background levels of radioactivity. Results of these measurements have shown that laboratory controls have been effective in minimizing the release of radioactivity to the environment.

Liquid Waste Activity

The liquid effluent from the Laboratory is sampled continually and a composite sample collected and analyzed weekly. This measured concentration may include fallout from rainfall and runoff that has entered the effluent line through the laboratory drainage system.

Radioactivity levels in liquid wastes discharged during the second quarter of 1960 are summarized below.

TABLE 1.—GROSS RADIOACTIVITY IN LIQUID WASTE

(Average concentrations in μμc/liter)

Periods	Gross Radioactivity
April 1960......................	160
May 1960......................	290
June 1960......................	92
Second quarter 1960	170

The concentration of strontium-90 in the liquid effluent is shown below. Data for the third and fourth quarters of 1959 and the first quarter of 1960 are reported here, since these were not available when the report for the first quarter was issued.

TABLE 2.—STRONTIUM-90 IN LIQUID WASTE

(Average concentrations in μμc/liter)

Periods	Strontium-90
Third quarter 1959..........	2.1
Fourth quarter 1959.........	1.8
First quarter 1960	0.9
Second quarter 1960.........	Analysis not completed

External Beta-Gamma Background Radiation Levels

Beta-gamma background radiation levels are monitored continuously and recorded at a monitoring station located on the western boundary of BAPL property as shown by figure 2. The average level for the second quarter of 1960 was 0.016 millirads per hour. This value is very similar to the first quarter average and within the range of background radiation levels measured by the AEC in 1957 throughout the United States.

Fallout Activity

Radioactive fallout is collected at six stations located at the periphery of BAPL property as shown on figure 2. The measurements of radioactive fallout collected by these stations provide only approximate values indicative of trends or variations. Due to their locations, these stations measure not only day-to-day fallout from the atmosphere, but may also detect fallout present in dust created by the movement of vehicles and construction work in the immediate vicinity.

The following table shows the data obtained from analyses of samples collected weekly at these stations during the second quarter of 1960.

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TABLE 3.—GROSS BETA RADIOACTIVITY IN FALLOUT

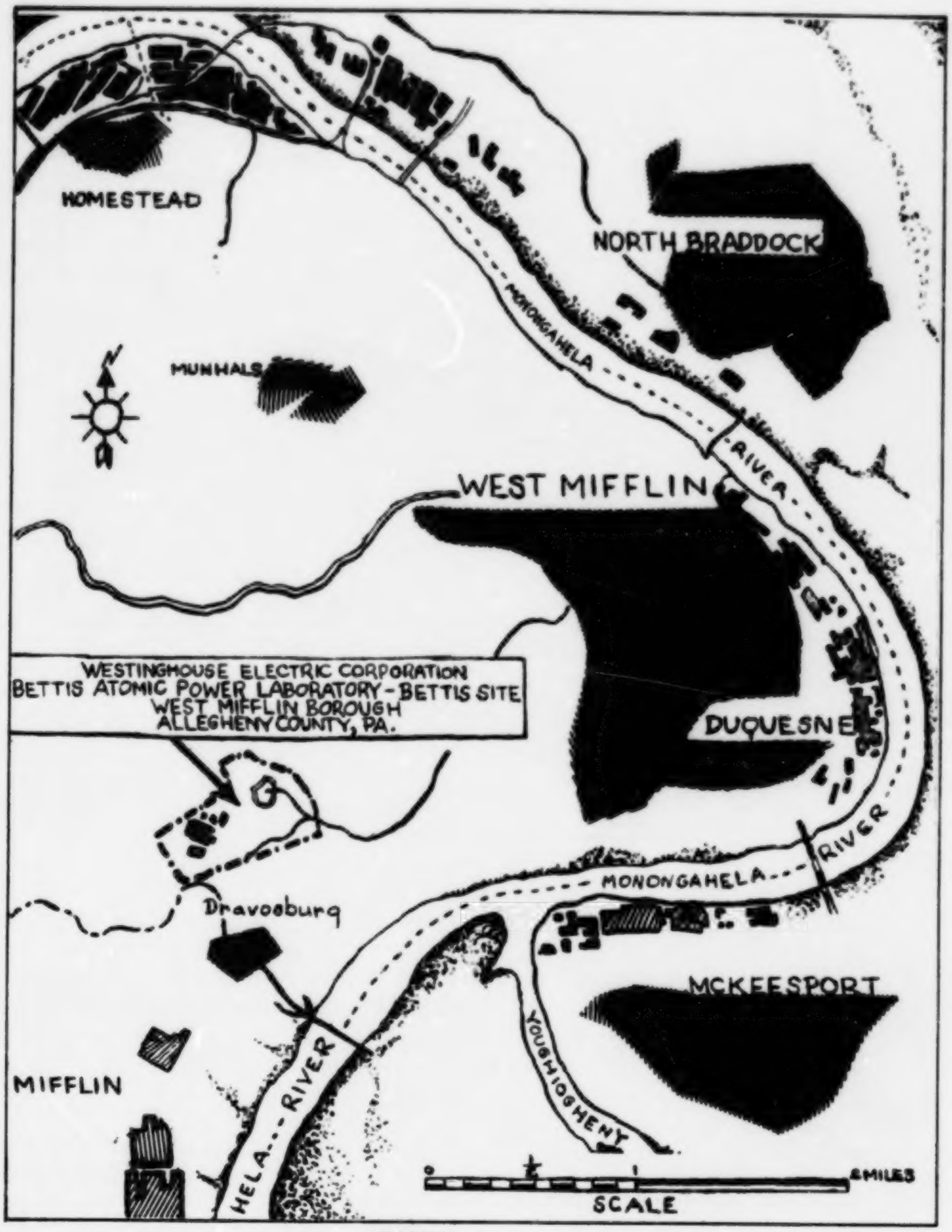
(Average amounts in mc/mi^2/month)

Periods	Stations upwind		Stations downwind			
	No. 1	No. 5	No. 2	No. 3	No. 4	No. 6
April 1960..................	8	7	8	6	7	6
May 1960....................	4	5	6	7	6	4
June 1960....................	4	3	4	4	3	3
Second quarter 1960.....	5	5	6	6	5	4

Based on prevailing wind directions, the sampling locations have been categorized as upwind or downwind and the data compared in an effort to determine what effect laboratory operations have on the fallout in surrounding areas. The above results reveal no significant differences to indicate the laboratory is contributing to radioactive fallout. Average concentrations of radioactive fallout measured during the second quarter were very similar to the average concentrations measured during the first quarter of 1960.

Soil Sampling

Soil samples from five locations on the perimeter of the laboratory are collected each year during the second and fourth quarters (see figure 2 for sampling locations). Average concentrations of radioactivity in the soil samples were 17uuc/gram of alpha and 26 uuc/gram of beta. These values are slightly lower, but not significantly different from the average concentrations of radioactivity measured in the soil during 1959.


HOMESTEAD
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MONONGAHELA
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MUNHALS
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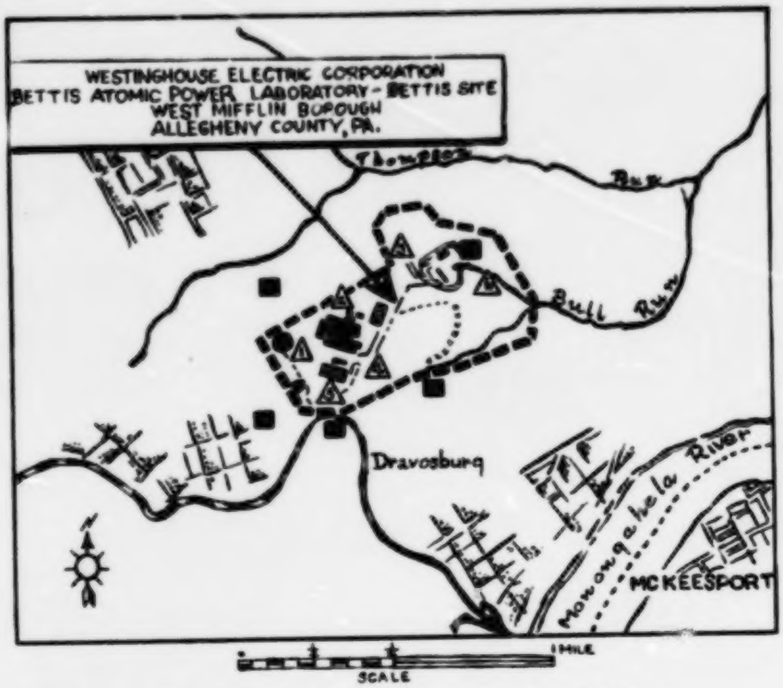
RIVER
WESTINGHOUSE ELECTRIC CORPORATION
BETTIS ATOMIC POWER LABORATORY - BETTIS SITE
WEST MIFFLIN BOROUGH
ALLEGHENY COUNTY, PA.
DUQUESNE
MONONGAHELA
RIVER
Dravosburg
MCKEESPORT
YOUGHIOGHENY
MIFFLIN
HELA
RIVER
0
½
1
2 MILES
SCALE

FIGURE 2

Sampling Station Locations


WESTINGHOUSE ELECTRIC CORPORATION
BETTIS ATOMIC POWER LABORATORY - BETTIS SITE
WEST MIFFLIN BOROUGH
ALLEGHENY COUNTY, PA.
Thompson Run
Bull Run
Dravosburg
Monongahela River
MCKEESPORT
N
1 MILE
SCALE

● Location of Background Radiation Monitoring Stations
△ Fallout Sampling Locations
■ Soil Sampling Locations

FIGURE 1

Bettis Atomic Power Laboratory and Surrounding Area

KNOLLS ATOMIC POWER LABORATORY

General Electric Company
Schenectady, New York

August 1960

Environmental levels of radioactivity at Knolls Atomic Power Laboratory (KAPL) for 1959 and first quarter of 1960 were reported in the December 1960 issue of Radiological Health Data. The following report presents a summary of the data for the second quarter of 1960.

The principal task of KAPL is to support the Naval Reactors Program of the Atomic Energy Commission in the development of nuclear power reactors for naval propulsion. The General Electric Company has been the operator of KAPL for the Atomic Energy Commission since 1946.

The Knolls Atomic Power Laboratory consists of two sites, the Knolls Site and the West Milton Site. The former is located five miles east of Schenectady, New York, on the south bank of the Mohawk River. The West Milton Site is located approximately 18 miles north of Schenectady, in Saratoga County.

Small amounts of radioactive materials are released to both the atmosphere and to two surface streams in the area—the Mohawk River at the Knolls Site and the Glowegee Creek at the West Milton Site. Prior to the release of this low level radioactivity to the environment, all KAPL liquid waste and exhaust air systems are carefully and continuously monitored. In addition to the in-plant control monitoring, an environmental monitoring program is conducted both on and off-site.

KAPL environmental monitoring locations are given in the attached figure. A brief description of the types of samples collected at the various locations is given in the referenced legend.

Liquid Radioactive Waste

West Milton Site

The amounts of radioactivity discharged from the West Milton Site as well as the results of the river sampling are presented in table 1. Alpha analyses are not performed since no alpha radioactivity is discharged from the West Milton Site.

TABLE 1.—GROSS BETA RADIOACTIVITY DISCHARGED AND DETECTED IN GLOWEGEE CREEK

Period 1960	Total waste discharged millicuries	Average concentration discharged μμc/liter	Average concentration in creek	
			Upstream μμc/liter	Downstream μμc/liter
April	0.58	130	9	3
May	0.26	98	3	4
June	0.43	100	8	7
Second quarter	1.27	110	7	5

Precipitation has a variable effect upon the Glowegee Creek samples which is dependent upon the amount of rainfall, creek flow and the period of sampling relative to the period of precipitation. The results of precipitation sampling are in the following table.

TABLE 2.—GROSS BETA RADIOACTIVITY IN PRECIPITATION 1960

(Average concentration in μμc/liter)

Period	Activity
April	153
May	73
June	77
Second quarter	103

Knolls Site

A continuous proportional sample of the Knolls Site combined sewer effluent is taken at the point of discharge to the Mohaw River. Analyses of weekly composite samples are made for radiochemical and toxic chemical content and these analyses show that strontium-90 is the principal component which has to be considered in hazard control. The radioisotopic average content of the combined sewer effluent for the second quarter of 1960 is presented in the following table.

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TABLE 3.—RADIOACTIVITY CONTENT OF THE KNOLLS SITE WASTE EFFLUENT

Second Quarter 1960

Radioisotope	Percent abundance	Average concentration μμc/liter
Ce^{144}, Pr^{144}	22.0	660
Sr^{89}	18.6	560
Sr^{90}	15.7	470
I^{131}	2.0	60
Ru^{106}	1.0	30
Cs^{137}	30.0	900
Zr^{95}, No^{95}	1.0	30
Total	90.3	

Knolls Site effluent is monitored continuously for alpha radioactivity. Since the quarterly discharge rate was less than 1% of the most restrictive environmental limit for alpha (Pu^{239}), the data are not reported.

Mohawk River water is sampled at locations upstream and downstream from the Knolls Site. The sample locations are: (1) at the General Electric Company Powerhouse eight miles upstream from the Knolls Site (a continuous sample after May 1959), (2) at the point of discharge to the Mohawk River from the Knolls Site (a continuous sample), (3) at the Vischer Ferry Powerhouse approximately two miles downstream (a continuous sample) and (4) at the City of Cohoes Pumping Station approximately thirteen miles downstream (a weekly grab sample).

The amounts of radioactive liquid waste discharged from the knolls Site as well as the results of the Mohawk River water sampling during the second quarter of 1960 are summarized below.

TABLE 4.—GROSS BETA RADIOACTIVITY DISCHARGED AND DETECTED IN THE MOHAWK RIVER (1960)

Period	Total waste discharged millicuries	Average concentrations discharged μμc/liter	Upstream	Downstream		
			GE power-house μμc/liter	Vischer Ferry μμc/liter	Cohoes*	
					Raw μμc/liter	Treated μμc/liter
April	282	5,800	4	ND	1	ND
May	80	1,500	1	3	5	ND
June	64	1,800	8	10	4	6
Second quarter	426	3,000	4	4	3	2

*Cohoes samples are weekly samples, therefore they are less representative than the samples collected upstream.

ND—Not detectable.

ENVIRONMENTAL AIRBORNE RADIOACTIVITY

Environmental airborne radioactivity is measured at three locations on the Knolls Site, four locations on the West Milton Site and at the General Electric Company Research Laboratory, approximately one mile west of the Knolls Site. Airborne radioactivity is sampled continuously and analyzed on a weekly basis. Each environmental monitoring station is equipped with film dosimeters to detect integrated gamma radioactivity levels. The averaged results of the airborne radioactivity analyses are given in the following table.

TABLE 5.—GROSS BETA AIRBORNE RADIOACTIVITY*

(Average concentrations in $\mu\mu c/m^3$)

Period 1960	Knolls Site	West Milton	Off-Site
April	0.11	0.19	0.06
May	.07	.15	.14
June	.10	.12	.19
Second quarter	.09	.15	.13

*Measurements of airborne radioactivity are made at least 48 hours after collection to allow the natural-occurring short half-life radioactive material to decay.

SOIL RADIOACTIVITY

Soil samples are collected bi-weekly at two locations, one on the Knoll Site and the other off-site. The off-site location is approximately two miles northeast of the Knolls Site. The sampling location was selected after a four-year study of wind directions at the Knolls Site. This station was upwind of the Knolls Site exhaust stacks 98 percent of the time in the period tested. The results of the beta radioactivity analyses of the soil samples are in the following table.

TABLE 6.—GROSS BETA RADIOACTIVITY IN SOIL SAMPLES (1960)

(Average concentrations in $\mu\mu c/gm$)

Period	Off-site	Knolls Site
April	21	13
May	22	14
June	18	20
Second quarter........	20	16

CONCLUSION

As a result of the environmental monitoring program conducted by the Knolls Atomic Power Laboratory at both the Knolls Site and the West Milton Site, it is concluded that the operations at these installations did not adversely affect the radioactivity levels of the local environment.

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S1C PROTOTYPE REACTOR FACILITY

Combustion Engineering, Inc.
Windsor, Connecticut

September, 1960

Environmental levels of radioactivity at the S1C Prototype Reactor Facility for first quarter of 1960 were reported in the November 1960 issue of the Radiological Health Data. The following report presents a summary of the data for the second quarter of 1960.

The S1C Prototype is a land-based nuclear submarine power plant facility. This facility is operated for the United States Atomic Energy Commission by the Naval Reactors Division of Combustion Engineering, Inc. at Windsor, Connecticut. The Prototype contains a pressurized water type nuclear reactor. It is used to conduct research and development work as well as to train personnel in operation of naval reactor power plants.

Nearly all of the radioactive wastes originate from the activation of minute amounts of impurities and corrosion products in the circulating water used as the reactor coolant. Small quantities of gaseous waste result from the activation of minute amounts of air dissolved in the coolant water.

Liquid Wastes

Approximately 78.6 μc of beta-gamma radioactivity was released during the quarter in $2.6x10^5$ gallons of waste effluent and dilution water. The table below is a summary of gross radioactivity released to the Farmington River.

TABLE 1.--SUMMARY OF GROSS RADIOACTIVITY RELEASED TO THE FARMINGTON RIVER

Month 1960	Total for month microcuries	Average per day microcuries	Average concentration released (μμc/liter)
April................	14.6	0.49	75
May..................	24.0	0.77	73
June.................	40.0	1.33	89
	78.6		

The Farmington River is sampled monthly at various locations for determination of alpha and beta-gamma activity in river water and mud. The results of this sampling are in table 2.

TABLE 2.--GROSS RADIOACTIVITY OF WATER AND MUD SAMPLES FROM FARMINGTON RIVER

Second quarter 1960

Location	Water samples				Mud samples			
	No. samples	Alpha μμc/liter	Beta Gamma μμc/liter	U ppm	No. samples	Alpha μμc/gram	Beta Gamma μμc/gram	U ppm
Upstream:								
Spoonville Bridge......	2	24.5	0.23	0.002	2	0.382	1.57	1.24
Above Brook...........	2	81.0	2.27	.001	2	0.382	2.12	0.86
Outlet:								
Mouth of Brook.........	2	94.2	0.23	.012	2	6.12	2.52	3.25
Downstream:								
Below Brook............	2	72.7	1.37	ND*	2	0.225	2.77	0.48
Rainbow Dam...........	2	24.2	0.23	ND	0	-	-	-
Windsor Bridge........	2	24.2	2.72	ND	2	0.270	2.68	1.16

*Non-detectable.

Table 3 presents a comparison of operational and pre-operational radioactivity levels of water samples from the Farmington River. Column headings, "Pre-operational averages" and "First quarter averages" were inadvertently interchanged in table 3, page 44 of the November 1960 Radiological Health Data, which presented the first summary for the S1C Facility. Second quarter, as well as corrected first quarter and pre-operational sample values are given in the following table.

TABLE 3.--COMPARISON OF OPERATIONAL AND PRE-OPERATIONAL WATER SAMPLES

(Average concentrations in μμc/liter)

Location	Operational				Pre-operational	
	First quarter		Second quarter			
	Alpha	Beta	Alpha	Beta	Alpha	Beta
Upstream	35	17	52.2	1.25	55	5.2
Outlet	50	4.5	94.2	0.23	54	4.5
Downstream	23	<4.5	40.4	1.44	30	5.6

Fallout

Radioactive fallout is collected on a weekly basis at six locations around the site and analyzed for gross radioactivity. Off-site fallout collections in neighboring towns are also made and analyzed for gross radioactivity and comparisons made as to on and off-site stations.

TABLE 4.—GROSS BETA RADIOACTIVITY IN FALLOUT

(Average quantities in mc/mi^2/month)

Location	Second quarter 1960	
	Number samples	Gross beta
Prototype site	53	3.13
Off-site in neighboring towns	71	3.07

From the above table it can be seen that fallout on-site and off-site are essentially equal and of very low level. This fallout has been attributed to residual activity from weapons tests rather than from S1C Prototype operations.

Airborne Waste Effluent

Ventilation air from the land-based submarine hull is continuously monitored at the exhaust stack. Table 5 summarizes the data for the second quarter of 1960.

TABLE 5.—AIRBORNE WASTE EFFLUENT RADIOACTIVITY AT EXHAUST STACK

(Average concentrations in $\mu\mu c/m^3$)

Periods	Gross beta
April 1960	71
May 1960	44
June 1960	47
Second quarter	54

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Conclusion

Measurements of the radioactivity in the Farmington River, the industrial waste effluent from the plant, air, and fallout in the vicinity of the SIC Prototype during the second quarter of 1960 showed no significant contribution of radioactivity from the Prototype to the environment.

SHIPPINGPORT ATOMIC POWER STATION

Duquesne Light Company
Beaver County, Pennsylvania

September 1, 1960

Environmental levels of radioactivity at the Shippingport Atomic Power Station for 1959 and first quarter of 1960 were reported respectively in July and December 1960, Radiological Health Data. The following report presents a summary of the data for the second quarter of 1960.

The Shippingport Atomic Power Station is the first large scale nuclear powered electric generating station, operated for the Atomic Energy Commission by the Duquesne Light Company. The plant was returned to operation in May 1960 after being shutdown nearly six months for the replacement of a portion of the fuel.

Liquid Radioactive Waste

The limits for discharge of radioactive wastes at Shippingport are based on criteria which depend on a knowledge of the radioactive materials which make up the waste and on recommended standards for unidentified mixtures of radioactive isotopes. If the quantity of a particular radioactive isotope is known,the discharge of that particular isotope may be based on the limit for that individual material. If the quantities of specific radioactive isotopes are not identified, then a more stringent limit for gross unknown mixtures of radioactive material is used. At Shippingport, most of the wastes are discharged according to the limit for gross unidentified mixtures of radioactivity. This is now done because total quantity of radioactivity in the waste is low and analyses for many specific radioactive isotopes are laborious and expensive. However, the discharge of a known lower hazard radioactive isotope called tritium is controlled separately, based on its own limit, since its formation in the reactor plant can be predicted with relative ease.

The waste discharge criteria for the plant imposes the restriction that radioactivity released to the environment does not increase the background radioactivity levels by more than 10 percent of the permissible concentrations recommended by the NCRP. This factor of 10 percent of the NCRP recommended permissible concentrations is usually applied to areas outside an atomic energy installation. At Shippingport, this criterion is applied to the actual plant discharges and no allowance is made for the dilution available in the environment except for that river water actually pumped through the plant for cooling the condensers.

The liquid effluent from the plant radioactive waste disposal system is carefully monitored before, during, and after release to the Ohio River to insure that excessive quantities of radioactive materials are not sent to the environment.

The liquid radioactive wastes discharged during the second quarter of 1960 are summarized below. The average concentrations of gross radioactivity shown in the table are in addition to normal background radioactivity in the condenser cooling water used for dilution in the effluent channel prior to discharge to the Ohio River.

TABLE 1.—SUMMARY OF GROSS RADIOACTIVITY RELEASED TO THE OHIO RIVER

Month	Total for month μc	Average per day μc	Average concentration in effluent channel during release μμc/liter
1960:			
April	48,793	1,630	6.2
May	10,949	354	2.9
June	11,830	394	2.4
1/10 MPC*	-	-	10

*One-tenth of the maximum permissible concentration in drinking water adapted from NBS Handbook 69, table 3.

The maximum total discharge in one day during the quarter was 3,737 microcuries. Tritium releases to the Ohio River are presented in the following table.

TABLE 2.—SUMMARY OF TRITIUM RELEASED TO THE OHIO RIVER

Month	Total for month curies	Average per day curies	Average concentration in effluent channel during release μμc/liter
1960:			
April	0	-	-
May	0.866	0.028	900
June	2.264	.075	1,300
1/10 MPC*	-	-	3×10^6

*One-tenth of the maximum permissible concentration in drinking water from table 1, NBS Handbook 69.

River water samples are taken continuously at four locations upstream and downstream from Shippingport and analyzed weekly. These locations are numbered and are marked as triangles on the attached map. Upstream sampling stations are located at Phillips Power Station (No. 1) of the Duquesne Light Company (about 20 miles upstream) and at the condenser cooling water intake at Shippingport (No. 2). The downstream continuous sampling stations are on the water intake lines of the water treatment plants at Midland, Pennsylvania (No. 4), and East Liverpool, Ohio (No. 5), approximately one and eight miles downstream respectively. Weekly grab samples were also collected during the quarter from the River at Dam No. 7, which is station No. 3 on the attached map. Grab samples were also collected in the effluent channel, and in the condenser cooling water intake and divided with Pennsylvania Department of Health representatives for duplicate analysis. The results of these duplicate grab samples are included with the river monitoring data below for comparison purposes.

TABLE 3.—GROSS RADIOACTIVITY CONCENTRATIONS IN THE OHIO RIVER DURING SECOND QUARTER 1960

(Average concentrations in μμc/liter)

Station	No. Samples	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
Upstream:							
Phillips	13	3.3	4.9	8.2	0.4	0.3	0.7
Shippingport Intake	13	3.9	5.0	8.9	.6	.6	1.2
Downstream:							
Midland	13	3.5	5.3	8.8	.5	.3	0.8
E. Liverpool	13	3.3	5.7	9.0	.5	.5	1.0
Dam No. 7*	13	3.8	6.0	9.8	.6	.3	0.9
Special Samples:**							
Effluent Channel	12	5.3	4.5	9.8	1.0	.5	1.5
Intake	12	5.2	4.0	9.2	1.0	.2	0.8

*Grab sample.
**Duplicate samples collected by Pennsylvania Department of Health.

The liquid radioactive wastes discharged from the Shippingport plant during the second quarter of 1960 have not shown a detectable effect on the background radioactivity level of the Ohio River.

Area Monitoring

Four area monitoring stations continuously monitored and recorded background levels of beta-gamma radiation and airborne particulate radioactivity in the Shippingport vicinity. These stations appear in figure 1 as circles with the station number inscribed. The data recorded by each station during this quarter was checked and tabulated weekly. Locations of the stations are identical to those reported in the last quarterly report.

The plant incinerator used for burning contaminated combustible material was operated only once during the quarter. The exhaust from the incinerator passes through a wet gas scrubber and a filter and is monitored at the stack exit during operation to determine the quantity of particulate radioactivity discharged. During this one day's operation, the particulate radioactivity monitored was 11 μμc/m^3 which is less than the permissible concentration for unidentified radioisotopes in air of 100 μμc/m^3 as recommended by the NCRP in NBS Handbook 69, table 4.

The data reported below are the results of measurements made only one hour after sample collection and therefore natural radon activity would be included. The average concentration of particulate radioactivity in the atmosphere during the second quarter of 1960 was found to be well below the maximum permissible concentration recommended by the NCRP.

TABLE 4.—AIRBORNE PARTICULATE RADIOACTIVITY

(Average concentrations in μμc/m^3)

Period	Station			
	SE of Main Building	1/2 mi. SW of Site	1/2 mi. NW of Site	1/2 mi. NE of Site
Second quarter 1960	1.1	1.1	1.3	1.5

TABLE 5.–GROSS BETA-GAMMA BACKGROUND RADIATION LEVELS

(Average values in millirad/hour)

Period	Station			
	SE of Main Building	1/2 mi. SW of Site	1/2 mi. NW of Site	1/2 mi. NE of Site
Second quarter 1960	0.016	0.014	0.013	0.012

Fallout

Radioactive fallout is collected at the four area monitoring stations. Samples are picked up weekly for analyses of gross beta radioactivity. The data for the second quarter are presented below.

TABLE 6.–GROSS BETA RADIOACTIVITY IN FALLOUT DURING SECOND QUARTER 1960

(Average concentrations in $mc/mi^2/mo$)

Station	Number samples	Activity
Upwind		
1/2 mi. SW of Site	13	10.6
1/2 mi. NW of Site........	13	12.4
Downwind		
SE of Main Building.......	13	11.9
1/2 mi. NE of Site	13	16.0

The prevailing wind direction at Shippingport is generally from West to East. Data from the upwind stations are compared with that from the downwind stations. The results do not indicate that the plant contributes any fallout to the surrounding area.

Soil Sampling

Soil samples were collected from twenty locations within a radius of approximately five miles of the Shippingport Site during the first quarter of 1960. Since the analyses were not complete in time for the first quarter report they are being included here.

TABLE 7.–GROSS RADIOACTIVITY IN SOIL SAMPLES

(Average concentrations in $\mu\mu c/gm$)

Period	Activity	
	Alpha	Beta
Pre-operational 1956-57	15.4	15.8
Calendar year 1959....................	17.5	18.0
First quarter 1960	17.5	15.1

General Conclusion

As a result of the environmental monitoring program conducted by the Shippingport Atomic Power Station, it is concluded that the operations at this station did not adversely affect the radioactivity levels of the local environment.

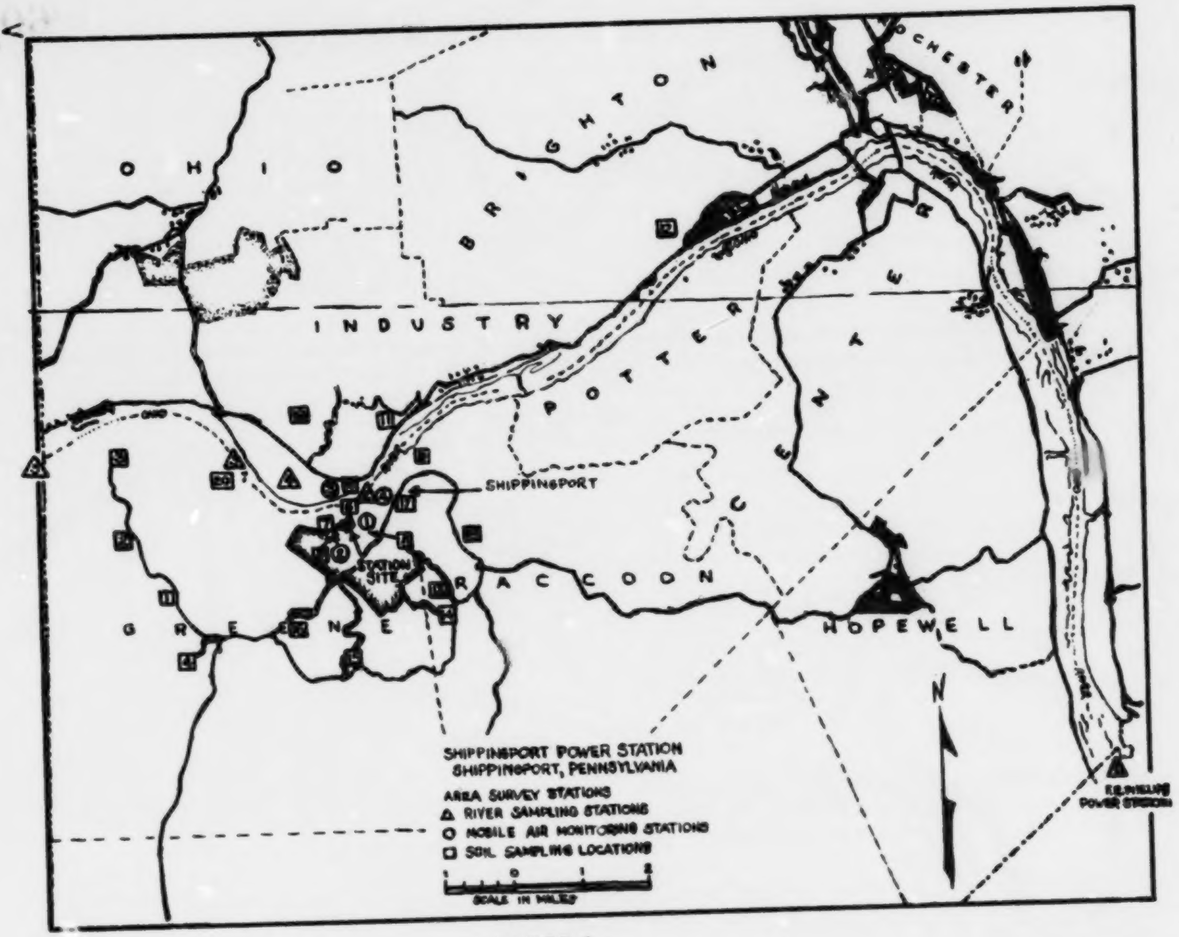
ROCHESTER
OHIO
BRIGHTON
INDUSTRY
POTTER
CENTER
SHIPPINGPORT
STATION SITE
RACCOON
GREENE
HOPEWELL
N
SHIPPINGPORT POWER STATION
SHIPPINGPORT, PENNSYLVANIA
AREA SURVEY STATIONS
△ RIVER SAMPLING STATIONS
○ MOBILE AIR MONITORING STATIONS
□ SOIL SAMPLING LOCATIONS
1 0 1 2
SCALE IN MILES
POWER STATION

FIGURE 1

FALLOUT STUDIES INTERPRETIVE REPORTS

U. S. Atomic Energy Commission

As a part of a cooperative arrangement with the AEC, the U. S. Weather Bureau has continued to analyze and interpret atmospheric fallout data. Several interpretive reports and notes resulting from such studies have been issued recently. These may be found in the AEC Health and Safety Laboratory Fallout Program Quarterly Summary Report, HASL-95, October 1, 1960. They are as follows:

1. L. Machta, "An Attempt to Compute Relative Removal Rates from the Polar and Temperate Latitude Stratosphere in the Spring of 1959".

2. N. Murayama and L. Machta, "Cs^{137}/Sr^{90} Ratios in the Stratosphere Ash Can Flights". "Ash Can" refers to the stratospheric balloon sampling program.

3. K. Telegadas, "Global Integrals of Monthly Sr^{90} Fallout, June-November 1959". This is a continuation of a similar report which appeared in HASL-84, April 1, 1960.

4. K. Telegadas and N. Murayama, "An Estimate of the Material Balance of Sr^{90} from the October 1958 USSR Series for the Period December 1958-November 1959".

Studies of fallout deposition data are also made by the AEC Health and Safety Laboratory in New York. A report is reproduced below on tungsten-185 deposition and its relationship to fallout from the U. S. weapons test series (HARDTACK I) in 1958 in the Pacific. This report also appears in HASL-95, pages 203-207. The U. S. Naval Research Laboratory has conducted a similar study. This was reported in Science 132, No. 3420, July 15, 1960.

TUNGSTEN-185 DEPOSITION ON THE EARTH'S SURFACE

Edward P. Hardy

Health and Safety Laboratory
U. S. Atomic Energy Commission

"During the 1958 Hardtack nuclear test series conducted by the United States in the Pacific, tungsten-185 was produced in some of the weapons tested. The presence of this radioactive nuclide of tungsten in the debris resulting from the testing, had made it possible to trace the radioactive fallout which resulted from this particular series of detonations. Tungsten-185 has been assayed in the monthly pot and funnel ion-exchange column collectors. A network of sampling stations is located throughout the world.

"In order to study the latitudinal distribution of tungsten-185 fallout, the monthly results have been averaged over quarterly periods of time and by twenty degree latitude bands as shown in figure 1. In this plot, the tungsten-185 values have been extrapolated to the midpoint of the sampling month. (This nuclide decays with a half-life of 75.8 days). The highest measured levels were detected in the northern hemisphere during the third quarter of 1958 and lesser but significant amounts were measured in the southern hemisphere during the same period of time. By the last quarter of 1958 and the first quarter of 1959, the measured levels of tungsten-185 had fallen off in the northern hemisphere and were closer to the levels detected in the southern hemisphere. The southern hemisphere values as measured each month did not show the marked drop that was evidenced in the northern hemisphere.

"In figure 2 the total megacuries of deposited tungsten-185 for all latitude bands which include sampling stations, have been plotted monthly. In this case the tungsten-185 values have been extrapolated to June 1, 1958. The graph shows that the actual arrival time, on a global basis, for the peak deposition of the Hardtack debris took place during March and April 1959. This may be evidence of a meteorological spring rise in the northern hemisphere since the Hardtack tests took place between May and August of 1958. This conclusion is also suggested from a consideration of the strontium-90 and strontium-89 data. Integration of this curve yields a figure of 100 megacuries of tungsten-185 as the total amount measured by the pot and ion-exchange column network for the period August 1958 through December 1959.

"Table 1 lists the strontium-90 and tungsten-185 concentrations in global fallout by quarters for 1958 and 1959. The tungsten-185 values have again been extrapolated to 6-1-58. By assuming a W^{185} Sr^{90} ratio of 360 at 6-1-58, it is possible to estimate the Hardtack strontium-90 contribution to each quarterly period. When this calculated amount of strontium-90 is subtracted from the total measured, a value for the remaining or residual strontium-90 is obtained. The last column of the table is the calculated percent of the Hardtack contribution to the total fallout measured. Since tungsten-185 measurements were not carried out on a global basis until August 1958, the value for the third quarter of 1958 may be low.

"The percent Hardtack contributions for the fourth quarter of 1958 and the four quarters of 1959 (on a global basis), appear to be fairly constant and average to about 20 percent. When the quarterly percent Hardtack contribution is calculated for the northern and southern hemispheres separately, the values are reasonably constant for the northern hemisphere but quite variable for the southern hemisphere. In the northern hemisphere during 1959 it appears that 80 percent of the fallout was due to weapons testing other than the Hardtack series. During the first quarter of 1959 in the southern hemisphere, the fallout was composed of Hardtack debris, debris from earlier 1958 testing, plus a presumably small contribution from the United Kingdom testing in September 1958. By the second quarter of 1959 in the southern hemisphere, most of the fallout appears to have been from Hardtack but in the third and fourth quarters, the Hardtack contribution falls off significantly. This may be an indication that debris from the fall 1958 Soviet tests had begun to deposit in the southern hemisphere during this last half of 1959. The strontium-89 to strontium-90 ratios indicated that fallout of a more recent origin was occurring in the southern hemisphere during this same time period."

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Figure 1 DEPOSITION OF TUNGSTEN-185 BY 20° LATITUDE BANDS

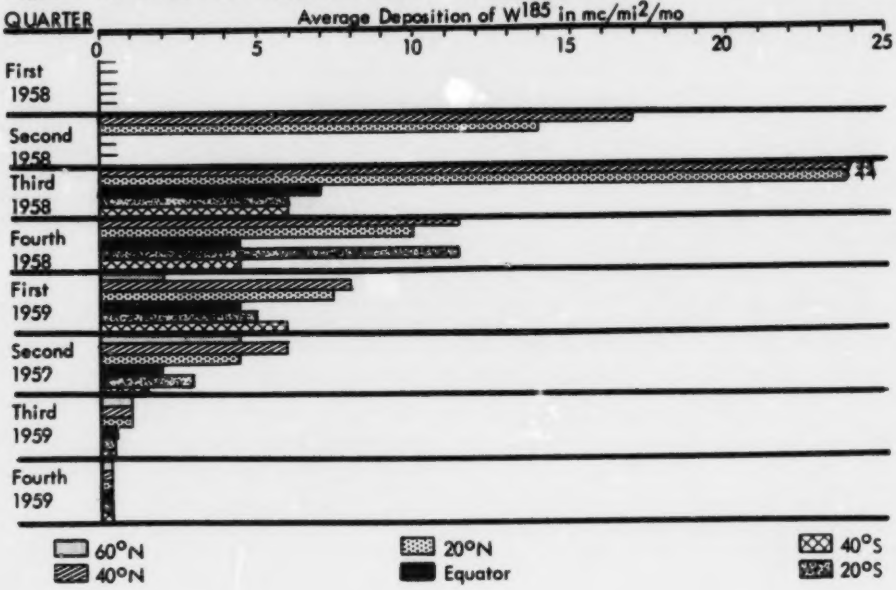

Figure 2 WORLD-WIDE DEPOSITION OF TUNGSTEN-185

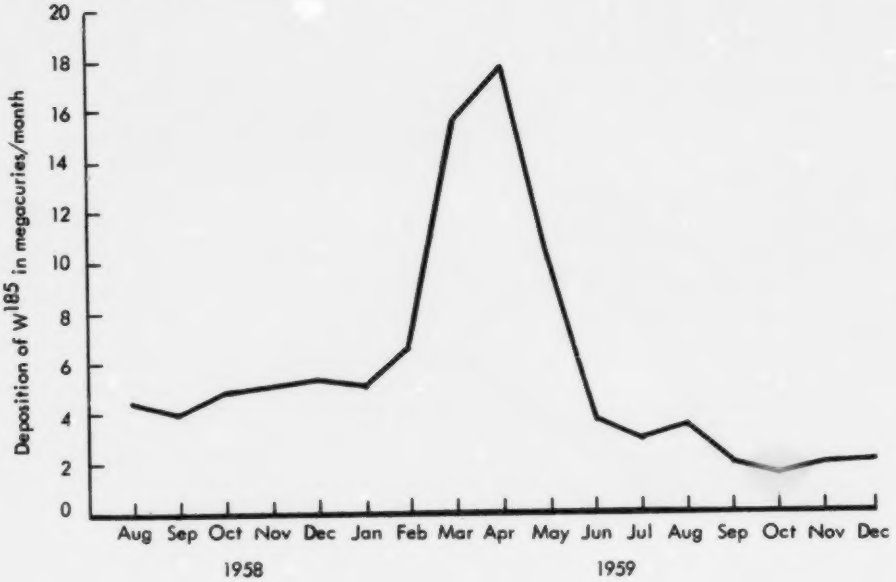

TABLE 1.—CALCULATED CONTRIBUTION OF HARDTACK FALLOUT TO TOTAL MEASURED

(Megacuries)

Period	Total Sr^{90} [1]	Total W^{185} [2]	Hardtack Sr^{90} [3]	Residual Sr^{90}	Percent hardtack debris
	Northern and Southern Hemisphere				
1958:					
First quarter	0.14				
Second quarter	0.24				
Third quarter	0.18	[4]8.4	[4]0.023	0.16	[4]13
Fourth quarter	0.21	15	0.042	0.17	20
Total	0.77	23.4	0.065	0.33	
	Northern Hemisphere				
1959:					
First quarter	0.36	18	0.050		14
Second quarter	0.41	22	0.062		15
Third quarter	0.12	9.0	0.025		22
Fourth quarter	0.04	2.9	0.008		19
Total	0.93	51.9	0.145		
	Southern Hemisphere				
First quarter	0.066	11	0.031		47
Second quarter	0.025	8.6	0.024		96
Third quarter	0.025	2.9	0.008		32
Fourth quarter	0.033	2.2	0.006		18
Total	0.149	24.7	0.069		
	Northern and Southern Hemisphere				
First quarter	0.43	29	0.081	0.35	19
Second quarter	0.43	30	0.086	0.34	20
Third quarter	0.14	12	0.033	0.11	24
Fourth quarter	0.08	5.6	0.014	0.06	19
Total	1.08	76.6	0.214	0.86	
Total—1958 and 1959	1.85	100	0.279	1.19	

[1] Based on HASL pot and funnel data.
[2] Based on HASL pot and funnel data (W^{185} extrapolated to 6-1-58).
[3] Calculated assuming W^{185}/Sr^{90} = 360 at 6-1-58.
[4] Estimate is low since global sampling did not begin until August 1958.

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RADIOLOGICAL HEALTH DATA

MONTHLY REPORT

FEBRUARY 1961

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

Division of Radiological Health

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PREFACE

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data is provided to the Division of Radiological Health by other Federal agencies, State health departments, and by foreign governments. Except where material is directly quoted, summaries are prepared by the staff of the Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
Atomic Energy Commission
Department of Defense
Department of Commerce
Department of Agriculture

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For personal and extra subscriptions to ***Radiological Health Data*,**
use the handy order form on page 61.

SECTION I.—AIR

PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

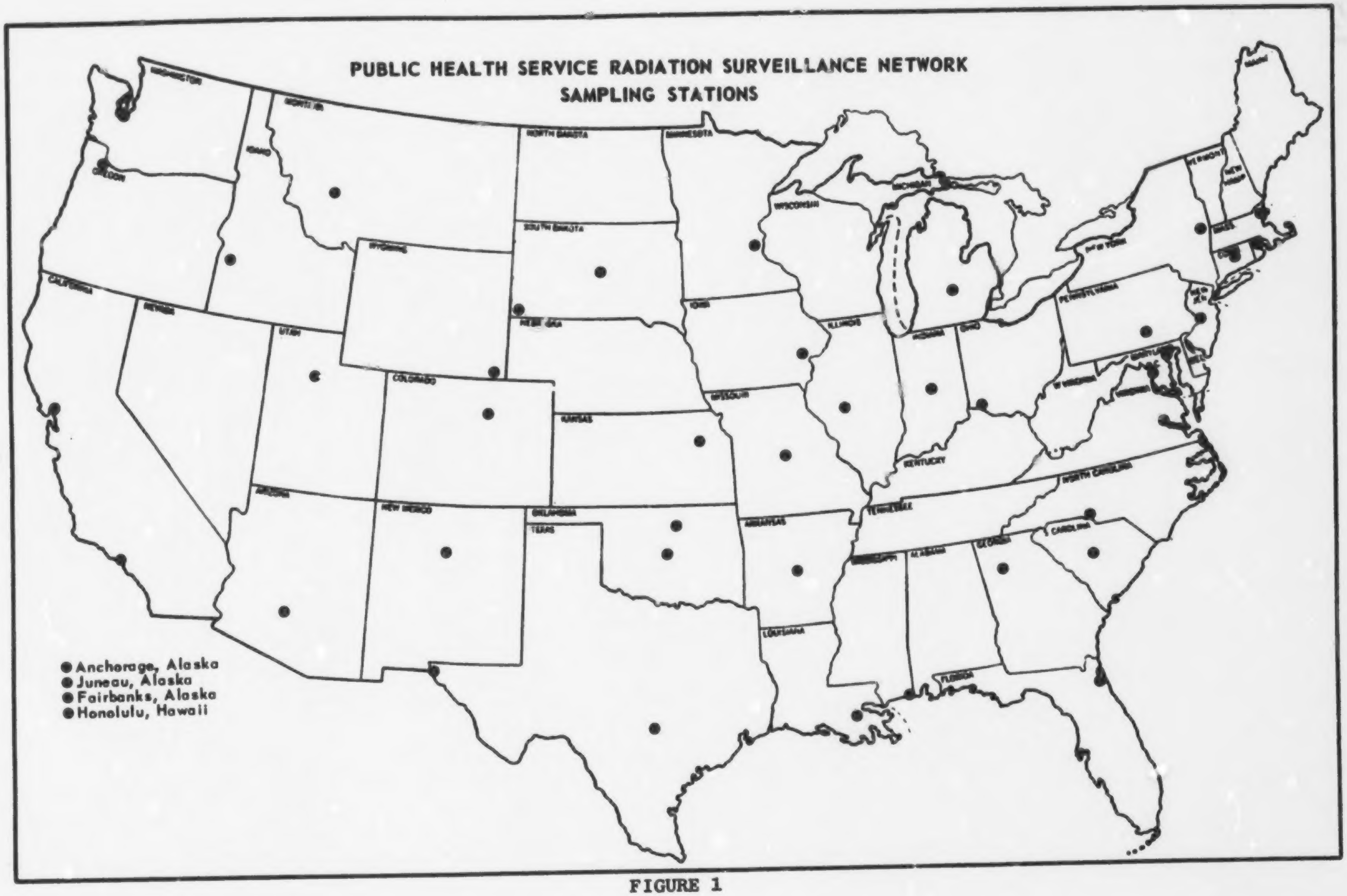
The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in environmental radiation due to radioactive fallout during nuclear weapons tests. The program has proven sufficiently valuable that it has been extended to a round-the-year basis and currently consists of 45 stations at urban locations (see figure 1) operated by State and local health department personnel with 2 operated by U. S. Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment, and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. However, field measurements do enable the operator to estimate the amount of beta activity of particulates in the air at the station five hours after collection, by comparison to a known source, using a portable survey meter. The filters are then forwarded to a laboratory in Washington, D. C., for more refined measurement with a thin window proportional counter.

Air samplers are in operation at the 45 stations on an average of 70 percent of the week. Air is drawn through a cellulose carbon loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small dust-like particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples.

About 85 percent of the stations collect samples of precipitation which are sent to Washington, D. C. for analysis. Values are now below limits of detection by present instrumentation. New equipment is being procured to measure lower values. Measurements have indicated that the bulk of deposited activity occurs through precipitation but concentrations in surface air are not directly relatable to the amount deposited through precipitation.

Table 1 presents a summary of the latest monthly data on gross beta radioactivity. Table 2 presents daily measurements of radon, thoron, and gross beta activity at the Cincinnati, Ohio, station.



PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK
SAMPLING STATIONS

● Anchorage, Alaska
● Juneau, Alaska
● Fairbanks, Alaska
● Honolulu, Hawaii
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
S. CAROLINA
NORTH CAROLINA
VIRGINIA
W. VIRGINIA
PENNSYLVANIA
NEW YORK
MARYLAND
NEW JERSEY
VERMONT
NEW HAMP.
MASS.
MAINE

FIGURE 1

TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR-GROSS BETA COUNTS

Public Health Service Radiation Surveillance Network

September 1960

Station location	Weighted average ($\mu\mu c/m^3$)	Maximum ($\mu\mu c/m^3$)	Minimum ($\mu\mu c/m^3$)
Alaska, Anchorage	<0.10	<0.10	<0.10
Alaska, Fairbanks	<0.10	<0.10	<0.10
Alaska, Juneau	<0.10	<0.10	<0.10
Arizona, Phoenix	<0.10	<0.10	<0.10
Arkansas, Little Rock	<0.10	0.11	<0.10
California, Berkeley	<0.10	0.12	<0.10
California, Los Angeles	<0.10	0.13	<0.10
Colorado, Denver	<0.12	0.17	<0.10
Connecticut, Hartford	<0.10	0.14	<0.10
District of Columbia	<0.11	0.28	<0.10
Florida, Jacksonville	<0.10	0.12	<0.10
Georgia, Atlanta	<0.11	0.32	<0.10
Hawaii, Honolulu	<0.10	<0.10	<0.10
Idaho, Boise	<0.11	0.13	<0.10
Illinois, Springfield	<0.10	0.12	<0.10
Indiana, Indianapolis	<0.10	0.20	<0.10
Iowa, Iowa City	<0.11	0.12	<0.10
Kansas, Topeka	<0.11	0.14	<0.10
Louisiana, New Orleans	<0.10	<0.10	<0.10
Maryland, Baltimore	<0.12	0.18	<0.10
Massachusetts, Lawrence	<0.10	<0.10	<0.10
Michigan, Lansing	<0.10	0.22	<0.10
Minnesota, Minneapolis	<0.10	0.12	<0.10
Mississippi, Pascagoula	<0.12	0.23	<0.10
Missouri, Jefferson City	<0.11	0.15	<0.10
Montana, Helena	<0.10	<0.10	<0.10
New Jersey, Trenton	<0.12	0.14	<0.10
New Mexico, Santa Fe	<0.10	0.11	<0.10
New York, Albany	<0.10	0.13	<0.10
North Carolina, Gastonia	<0.12	0.20	<0.10
Oklahoma, Oklahoma City	<0.10	0.11	<0.10
Oklahoma, Ponca City	<0.10	<0.10	<0.10
Oregon, Portland	<0.11	0.17	<0.10
Pennsylvania, Harrisburg	<0.10	0.15	<0.10
Rhode Island, Providence	<0.11	0.16	<0.10
South Carolina, Columbia	<0.10	<0.10	<0.10
South Dakota, Edgemont	-	-	-
South Dakota, Pierre	<0.10	0.11	<0.10
Texas, Austin	<0.10	0.12	<0.10
Texas, El Paso	<0.16	0.53	<0.10
Utah, Salt Lake City	<0.10	0.14	<0.10
Virginia, Richmond	<0.10	0.12	<0.10
Washington, Seattle	<0.10	<0.10	<0.10
Wyoming, Cheyenne	<0.10	<0.10	<0.10

TABLE 2.–RADON AND THORON MEASUREMENTS

Public Health Service Radiation Surveillance Network
Station at Cincinnati, Ohio

September 1960

Date	Continuous sample collection			Radon[a] AM ($\mu\mu c/m^3$)	Radon[b] PM ($\mu\mu c/m^3$)	Thoron[c] ($\mu\mu c/m^3$)	Beta[d] activity ($\mu\mu c/m^3$)
	Sample change time	Sampling period (hours)	Volume (m^3)				
1	0830	24.3	29.7	945	178	6.3	2.3
2	0815	23.7	28.9	997	242	8.5	0.1
6	0815	95.9	115.7	423	155	7.0	0.2 (4)
7	0810	23.8	28.1	1336	241	10.9	5.3
8	0815	24.0	29.9	891	317	8.2	3.0
9	0805	23.8	29.3	302	186	5.2	0.3
12	0815	72.1	88.3	874	170	8.1	1.1 (3)
13	0815	23.9	29.3	263	72	3.1	1.1
14	0815	23.9	29.4	1102	174	8.8	3.4
15	0810	23.8	30.0	643	182	6.6	2.8
16	0810	23.9	28.8	1207	196	10.1	0.3
19	0810	71.9	88.4	345	215	4.7	0.7 (3)
20	0810	23.9	29.4	495	131	2.1	0.9
21	0830	24.3	29.5	628	209	2.9	1.0
22	0915	24.7	30.5	(e)	309	5.5	2.1
23	0810	22.8	28.3	1139	258	8.1	0.3
26	0810	71.9	88.0	1176	149	11.1	1.5 (3)
27	0820	24.1	29.5	1178	501	9.9	3.2
28	0810	23.8	29.1	457	335	5.8	2.1
29	0815	24.0	29.1	1034	231	8.3	3.0
30	0820	24.0	29.2	1289	434	13.9	0.4
	Average..................................			786	232	7.8	1.7

(a) Measured within a few minutes of removal of filter from sampler and extrapolated back to collection time (uncorrected for thoron daughter interference).

(b) Filters are temporarily withdrawn from sampler at about 3 PM and counted. (Values are corrected back to removal time.) The filters are then replaced on sampler to complete the sampling period of about 24 hours.

(c) Thoron from alpha activity of filter sample counted 7 hours after taking a 24-96 hour sample.

(d) Gross beta activity when counted one day after end of sampling or later as indicated by numeral in parentheses. This activity is due principally to thoron except when counted after 3 or more days.

(e) Counter out of order.

U. S. NAVAL RESEARCH LABORATORY RADIOACTIVITY MEASUREMENTS

Radioactivity measurements of air-filter samples collected at various sites along the 80th Meridian (West) are made by the U. S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during June 1960 is shown in table 1, while the radioactivity profile for the same month is shown in figure 1. All radioactivity concentrations are given in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

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TABLE 1.--DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION

U. S. Naval Research Laboratory

September 1960

(Disintegrations/minute per cubic meter)

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador
1	-	0.05	0.17	0.10	0.06	0.03	0.03
2	-	0.05	0.17	0.10	0.06	0.03	0.03
3	-	0.07	0.12	0.09	0.08	0.04	0.03
4	-	0.07	0.12	0.09	0.08	0.04	0.03
5	-	0.07	0.12	0.09	0.08	0.04	0.03
6	-	0.06	0.09	0.12	0.13	0.02	0.04
7	-	0.06	0.09	0.12	0.05	0.02	0.04
8	-	0.09	0.16	0.11	0.05	0.06	0.04
9	-	0.09	0.16	0.11	0.05	0.06	0.04
10	-	0.01	0.09	0.11	0.07	0.05	0.06
11	-	0.01	0.09	0.11	0.07	0.05	0.06
12	-	0.01	0.09	0.11	0.07	0.05	0.08
13	-	0.04	0.11	0.12	0.06	0.11	0.06
14	-	0.04	0.11	0.12	0.06	0.11	0.08
15	-	0.13	0.15	0.14	0.04	0.06	0.03
16	-	0.13	0.15	0.14	0.04	0.06	0.03
17	-	0.09	0.12	-	0.03	0.10	0.03
18	-	0.09	0.12	-	0.03	0.10	0.05
19	-	0.09	0.12	-	0.03	0.10	0.06
20	-	0.04	0.11	0.27	0.03	0.04	0.05
21	-	0.04	0.11	0.27	0.03	0.04	0.05
22	-	0.04	0.09	0.10	0.03	0.05	0.05
23	-	0.04	0.09	0.10	0.03	0.05	0.05
24	-	0.02	0.10	0.14	0.03	Tr	0.03
25	-	0.02	0.10	0.14	0.03	Tr	0.03
26	-	0.02	0.10	0.14	0.03	Tr	0.05
27	-	0.02	0.13	0.15	0.03	0.08	0.04
28	-	0.02	0.13	0.15	0.03	0.08	0.03
29	-	0.06	0.11	0.15	0.04	0.17	0.02
30	-	0.06	0.11	0.15	0.04	0.17	0.02
Mean value	-	0.05	0.12	0.13	0.05	0.06	0.04

Tr= Trace.

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TABLE 1.--DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION--Con.

U.S. Naval Research Laboratory

September 1960

(Disintegrations/minute per cubic meter)

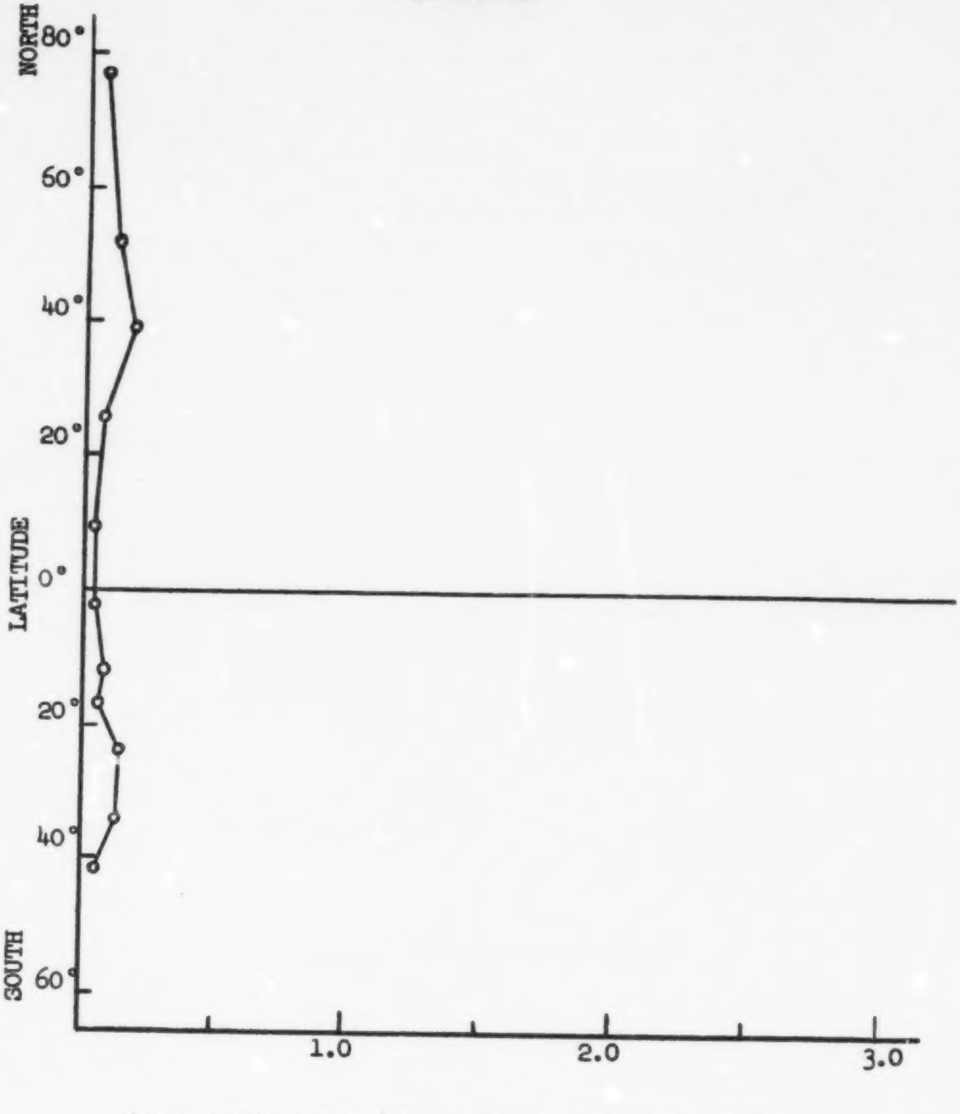
Day	Miraflores, Panama Canal	Mauna Loa, Hawaii	Miami, Florida	Washington, D. C.	Moosonee, Ontario, Canada	Thule Greenland	Bravo Arctic Ice Floe
1	0.01	0.12	-	0.11	0.16	0.08	0.02
2	0.01	0.12	0.15	0.23	0.16	0.08	0.02
3	0.02	0.10	0.08	0.23	0.06	0.08	0.02
4	0.02	0.10	0.08	0.23	0.06	0.10	0.02
5	0.02	0.10	0.08	0.23	0.06	0.10	0.02
6	0.02	0.11	0.05	0.30	0.22	0.05	0.07
7	0.02	0.11	0.05	0.30	0.22	0.05	0.07
8	0.03	0.09	0.08	0.30	0.12	0.04	0.07
9	0.03	0.09	0.08	0.30	0.12	0.04	0.07
10	0.02	0.07	0.07	0.16	0.12	0.07	0.07
11	0.02	0.07	0.07	0.16	0.11	0.07	0.07
12	0.02	0.07	0.07	0.16	0.11	0.07	0.07
13	0.05	0.13	0.08	0.16	0.14	0.05	0.02
14	0.05	0.13	0.08	0.16	0.14	0.05	0.02
15	0.04	0.12	0.08	0.24	0.05	0.06	0.02
16	0.04	0.12	0.08	0.24	0.05	0.06	0.02
17	0.03	0.09	0.06	0.20	0.12	0.03	0.02
18	0.03	0.09	0.06	0.20	0.12	0.03	0.02
19	0.03	0.09	0.06	0.20	0.12	0.03	0.02
20	0.02	0.07	0.06	0.08	0.14	0.04	0.02
21	0.02	0.07	0.06	0.08	0.14	0.04	0.02
22	0.03	0.25	0.03	0.08	0.09	0.03	0.02
23	0.03	0.25	0.03	0.08	0.09	0.03	0.02
24	0.03	0.08	0.03	0.14	0.14	0.13	0.02
25	0.03	0.08	0.03	0.14	0.14	0.13	0.02
26	0.03	0.08	0.03	0.14	0.14	0.13	0.02
27	0.02	0.06	0.07	0.12	0.10	0.09	0.02
28	0.02	0.06	0.07	0.12	0.10	0.09	0.02
29	0.03	0.03	0.12	0.14	0.11	0.06	0.02
30	0.03	0.03	0.12	0.14	0.11	0.06	0.02
Mean value	0.03	0.10	0.07	0.18	0.12	0.07	0.03

PROFILE OF BETA-ACTIVITY

AVERAGE MEASUREMENTS OF SURFACE AIR
AT STATIONS ALONG THE 80TH MERIDIAN (WEST)

U. S. Naval Research Laboratory

September 1960



Average Fission Product Beta-Activity (dpm/m^3)

Figure 1

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SECTION II.—FOOD, OTHER THAN MILK

THE ANNUAL AND GEOGRAPHICAL INFLUENCES ON THE STRONTIUM-90 INTAKE IN JAPANESE DIET

The Nutrition Division of the Ministry of Public Health in Japan has obtained an index on average amount of each food consumed through quarterly random sampling surveys of families in 180 districts. The strontium-90 concentration determined on each food is multiplied by the measured food intake, and these values summed to yield the value of average daily intake of strontium-90 in the Japanese diet. These values for four cities in Japan are shown in figure 1. The inherent error in this method is admittedly the fact that there can be a large variation in strontium-90 content of each food, dependent upon such factors as : (a) type of contamination; (b) location where vegetables, cereals, fruits, etc. are grown; (c) condition of medium where grown; (d) method of preparation for cooking and (e) processing and refining of foods. To arrive at an average value of Sr^{90} for each food, many assays of each food would be required. Hence, this procedure is expensive and cumbersome. Despite these difficulties, this method was used in arriving at the data represented in figure 1 and tables 1 and 2.

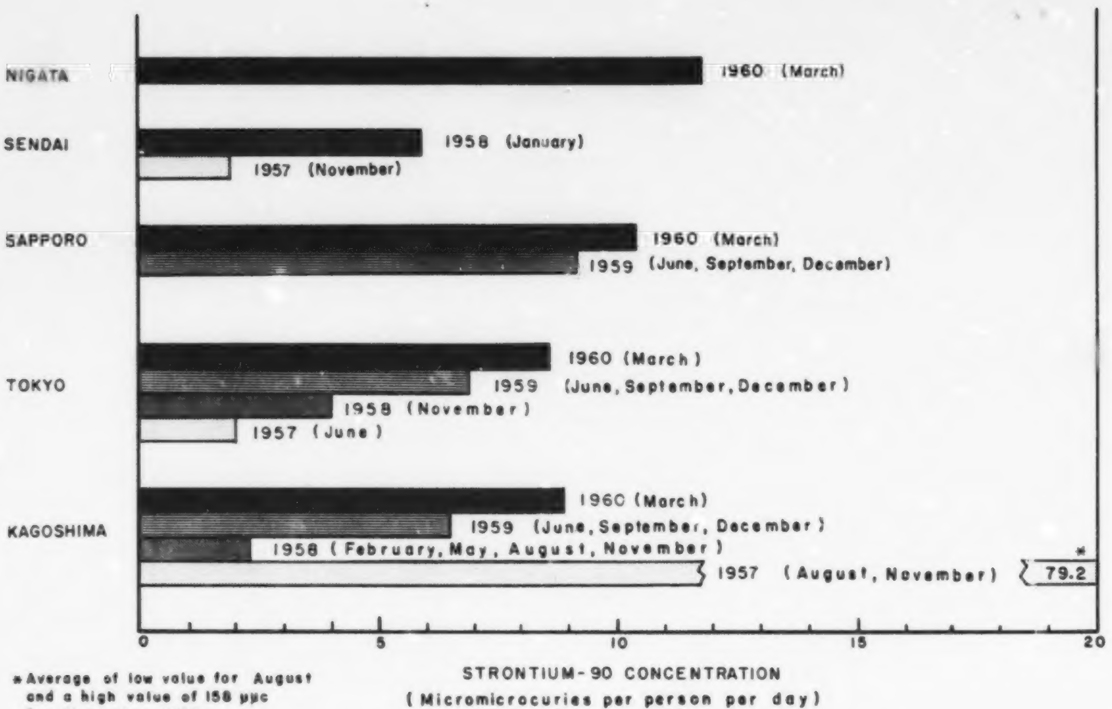
The National Institute of Nutrition in Japan has used a different system for collecting food samples to arrive at a subsequent assay of foods for daily dietary intake of strontium-90. The Institute used a "standard recipe" or recommended intakes of foods as a basis for collection and radiological assay of foods. It is of interest for comparative purposes to note the discrepancies between daily intakes of classes of foods determined by actual survey (method A) and that by "standard recipe" (method B), table 3. It is obvious that the "standard recipe" reflects the viewpoints of nutritionists as to increased intake of food classes which contribute important nutrients in the diet. For example, the differences in intake of meats, milk, eggs and leafy green vegetables are quite indicative (columns A and B in table 3).

Although the monthly measurements for Sr^{90} on the Japanese diet for the five respective cities shown in figure 1 are perhaps not extensive enough to arrive at a meaningful average, it would appear that Sendai had the lowest concentration for the period 1957 and 1958 and Nigata had the highest value in 1960. Intermediate values were shown for Tokyo, Sapporo and Kagoshima. Dr. Yoshi Hiyama, University of Tokyo, offers no explanation for the high value at Kagoshima for November 1957 other than to suggest a high concentration of particulate fallout on the food crops, particularly leafy vegetables. When comparing the Japanese values to those in the United States dietary (approximately 15 to 20 μμc Sr^{90}/day) the Japanese diet would seem to present a lower level of contamination.

In table 1, Dr. Hiyama has presented the correlation coefficients between cumulative ground deposit, fallout rate and level of strontium-90 contamination in the Japanese diet. The correlation between cumulative ground deposit of strontium-90 (mc/km^2) and daily dietary intake of strontium-90 (μμc and μμc/gm Ca) is quite high. There is no significant correlation between fallout rate and dietary intake of strontium-90.

Data from report by Dr. Yoshio Hiyama (University of Tokyo) "Annual and Geographical Change of Sr^{90} Dietary Intake of Japanese During 1957-1960--August 1960."

STRONTIUM-90 CONCENTRATION IN JAPANESE DIET OF FIVE SELECTED CITIES DURING 1957, 1958, 1959 and 1960



*Average of low value for August and a high value of 158 μμc for November 1957.

Figure 1

TABLE 1.--STRONTIUM-90 CONCENTRATION IN JAPANESE DIET

(Reference table for Figure 1.)

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Location	Date	Daily per capita intake Sr^{90}	
		μμc	μμc/gm Ca
Tokyo	1957-June	2.03	3.6
	1958-November	4.07	6.8
	1959-June	7.7	10.9
	September	8.3	13.7
	December	7.5	14.4
	1960-March	8.5	21.9
Kagoshima	1957-August	0.5	0.74
	November	158.0	153.0
	1958-February	2.33	2.82
	May	0.60	1.00
	August	0.48	0.84
	November	5.7	8.5
	1959-June	6.8	12.0
	September	6.9	11.1
	December	5.8	12.1
	1960-March	7.7	20.1
Sapporo	1959-June	8.2	14.5
	September	9.3	14.9
	December	9.7	17.4
	1960-March	10.2	14.6
Nigata	1960-March	11.7	25.1
Sendai	1957-November	1.72	4.06
	1958-January	5.59	5.3
1957-59 average for country..........		6.2	11.2
1959 average for country..............		7.8	13.4

TABLE 2.—CORRELATION COEFFICIENTS BETWEEN FALLOUT, CUMULATIVE GROUND DEPOSIT AND STRONTIUM-90 CONTENT OF JAPANESE DIET

Strontium-90 content	Cumulative ground deposit (mc/km^2)	
	June 1960	July 1960
Daily intake (μμc Sr^{90})...	0.97	0.98
μμc Sr^{90}/gm Ca............	0.91	0.90

Strontium-90 content	Fallout rate (mc/km^2/month)				
	1959		1960		
	August	August-September	May	June	July
Daily intake (μμc Sr^{90})...	0.16	- 0.90	- 0.41	0.04	- 0.07
μμc Sr^{90}/gm Ca............	- 0.09	- 0.84	0.01	-0.24	- 0.31

TABLE 3.–COMPARISON IN DAILY FOOD INTAKES IN JAPAN BY SURVEY METHOD AND BY STANDARD RECIPE CALCULATION

Food materials	Method A (1958)* (gms)	Method B* (gms)
Cereals	421.4	439.7
Starchy roots...............	73.0	75.9
Sugars.........................	12.3	11.6
Fats............................	5.7	8.6
Beans	71.0	53.75
Fish-Shellfish...............	74.9	83.0
Meats..........................	17.6	44.7
Eggs	14.8	23.5
Milk............................	22.0	75.0
Vegetables, leafy green	45.8	130.0
Oranges-Tomatoes	23.0	24.0
Other vegetables	116.6	125.0
Other fruits.................	54.2	10.0
Pickled vegetables	52.7	16.6
Dried vegetables	2.3	0.23

*Method A–Survey of families in 180 districts.
Method B–Calculated from "standard recipe."

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SECTION III.—MILK

PUBLIC HEALTH SERVICE MILK MONITORING PROGRAM

The original Public Health Service Milk Monitoring Program consisted of 12 sampling stations of which 9 are still active. Raw milk was spot sampled at these stations. During 1960 a new sampling program of about 60 stations was established. Processed milk was sampled at these stations. Since the sampling procedures for the raw milk sampling stations and the processed milk area sampling stations are different, they are described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Alabama, and the Southwestern Radiological Health Laboratory at Las Vegas, Nevada, provide this service for the new program.

The purpose of the two sampling programs is not the same. The original network was established to develop sampling and radiochemical analytical proficiencies. During the existence of this program it became apparent that a broader sampling program, more directly related to the milk consumed by the population, was necessary, and the Public Health Service and the Department of Health, Education, and Welfare moved to provide facilities for this change. This resulted in the transition from the program of sampling raw milk, collected from milksheds of limited size, to a sampling program designed to be representative of the processed milk consumed in a given municipality.

In some instances the designated points are the same as those which were reported originally. The establishment of the new processed milk area sampling stations does not preclude the need for further raw milk sampling from the selected milkshed serving the same city. It is important that both networks be in operation for a sufficient period of time to provide an overlap for the purpose of comparative study.

Because of the different sources of these samples, changes in the collecting system, and the utilization of different laboratory techniques, differences were anticipated in the amounts of radioactivity found in the milk under the two programs. For this reason, an investigation to determine the comparability of the two programs was begun in January 1961. This investigation covers all possible factors including both the laboratory methodology and collecting methods. Until this study has been completed, and additional experience has been gained under the new program, no valid interpretation can be made of any differences of radioactivity in milk samples collected under the two systems.

Publication of the data will normally follow about four months after collection of samples because of the time required for shipment, processing, decay product build-up, compilation of the data, clearance and publication procedures.

Raw Milk Sampling Stations

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Public Health Service to determine trends in our changing environment, including measurement of amounts of radioactivity in water, air, milk and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop effective collection systems and radiochemical analysis procedures to make them more suitable for larger scale programs.

The criteria on which the selection of the original sampling stations were based appeared in the discussion sections of all Volume I issues of Radiological Health Data.

One-gallon raw milk samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analysis. It is estimated that these samples represent 2,000-gallon lots. The concentration of iodine-131, barium-140, cesium-137 and naturally-occurring potassium-40 are all currently being measured, when present in the milk, by gamma scintillation spectroscopy. Total radiostrontium and strontium-90 are determined following radiochemical separations, the strontium-90 being calculated by measuring the build-up in a two-week period of the daughter decay product, yttrium-90, using a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter with the strontium-89 calculated as the difference.

April through September 1960 issues of Radiological Health Data list references for technical descriptions of the methodology of analyses used.

October data for the raw milk sampling stations are presented in table 1.

Processed Milk Area Sampling Stations

The monitoring of milk has been expanded to provide additional information on levels of radioactivity in milk consumed by the public. The new stations have been established in cooperation with State and local health and milk sanitation agencies. The cities have been selected in order to provide adequate coverage from the combined viewpoints of production areas and consuming population. The emphases on this expanded sampling and radioassay program are:

1. Measuring the radioactivity levels of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the processing plant, and
2. Providing one sampling point within each State with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving the milk production and milkshed area characteristics.

The new network was designed to sample processed milk rather than the raw product. The sampling procedure was developed to provide a sample from one day's sales per month in a community which will be as representative of the total supply as can be achieved under practical conditions. The sample will be a composite of those plants supplying not less than 90% of the city's milk supply. The contribution from each plant to the total sample will be approximately proportional to volume of milk sold.

The samples from the new stations are collected with the assistance of the various State and local health and milk sanitation agencies and are shipped for analysis to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples from the 30 states generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the western states.

At the present time radioassays for Sr^{89}, Sr^{90} and Cs^{137} are being performed. Other radionuclides of concern to public health agencies will be included for assay as necessary for complete monitoring of the milk supply.

Data from the two laboratories are presented in table 2.

TABLE 1.--RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program
Robert A. Taft Sanitary Engineering Center
Raw Milk Sampling Stations

September 1960

(Radioactivity in $\mu\mu c$/liter)

Area	Calcium (grams/liter)		Iodine-131		Strontium-89		Strontium-90		Barium-140		Cesium-137	
	Sept.	Yearly average	Sept.	Yearly average	Sept.	Yearly average	Sept.	Yearly average	Sept.	Yearly average	Sept.	Yearly average
Atlanta, Ga.	1.11	1.12	ND	<10	ND	<5	14	15	ND	<10	20	43
Austin, Texas	1.10	1.09	ND	<10	ND	<5	3	5	ND	<10	10	19
Chicago, Illinois	1.12	1.09	ND	<10	ND	<5	7	10	ND	<10	20	34
Cincinnati, Ohio	1.05	1.11	ND	<10	ND	<5	8	11	ND	<10	10	27
New York, New York	1.08	1.07	ND	<10	ND	<5	8	10	ND	<10	10	30
Sacramento, Calif.	1.15	1.10	ND	<10	ND	<5	4	4	ND	<10	5	10
Salt Lake City, Utah	1.05	1.09	ND	<10	ND	<5	5	7	ND	<10	15	33
Spokane, Washington	1.13	1.10	ND	<10	ND	<5	8	12	ND	<10	25	47
St. Louis, Missouri	1.10	1.21	ND	<10	ND	<5	15	20	ND	<10	20	35

Samples are taken at one sampling point from the milk supply of the areas listed above.
ND--No detectable activity

TABLE 2.—RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program

Processed Milk Area Sampling Stations—September 1960

(Radioactivity in μμc/liter)

Area	Calcium (grams/liter)		Strontium-89		Strontium-90		Cesium-137	
	Sept.	Average to date	Sept.	Average to date	Sept.	Average to date	Sept.	Average to date
Albuquerque, N. Mex.	1.01	1.16	ND	<5	4	4	-	-
Atlanta, Ga.	1.27	1.24	ND	<5	11	11	<10	<10
Austin, Tex.	1.16	1.13	ND	<5	3	2	<10	<10
Baltimore, Md.	1.18	1.08	ND	<5	7	6	<10	<10
Boston, Mass.	1.20	1.17	ND	<5	8	13	<10	20
Buffalo, N. Y.	1.14	1.19	ND	<5	6	7	<10	<10
Burlington, Vt.	1.30	1.19	ND	<5	7	9	<10	10
Charleston, S. C.	1.24	1.22	ND	<5	10	10	<10	10
Charleston, W. Va.	1.14	1.16	ND	<5	8	9	<10	<10
Charlotte, N. C.	1.24	1.19	ND	<5	14	12	<10	10
Chattanooga, Tenn.	1.27	1.27	ND	<5	11	11	<10	<10
Chicago, Ill.	1.16	1.09	ND	<5	6	7	<10	<10
Cincinnati, Ohio	1.16	1.15	ND	<5	8	8	<10	<10
Cleveland, Ohio	1.16	1.09	ND	<5	8	8	<10	<10
Dallas, Tex.	1.23	1.23	ND	<5	6	6	<10	<10
Denver, Colo.	1.02	1.11	ND	<5	6	7	-	-
Des Moines, Iowa	0.94	1.03	ND	<5	7	7	-	20
Detroit, Mich.	1.20	1.13	ND	<5	8	7	<10	<10
Grand Rapids, Mich.	1.22	1.20	ND	<5	7	8	<10	<10
Hartford, Conn.	1.14	1.15	ND	<5	9	9	<10	15
Helena, Mont.	1.06	1.08	ND	<5	8	6	-	25
Honolulu, Hawaii	1.06	1.08	ND	<5	7	5	-	40
Idaho Falls, Idaho	1.03	1.05	ND	<5	6	5	-	40
Indianapolis, Ind.	1.19	1.16	ND	<5	6	6	<10	<10
Jackson, Miss.	1.26	1.24	ND	<5	10	12	<10	<10
Kansas City, Mo.	1.01	1.08	ND	<5	10	8	-	-
Laramie, Wyo.	0.98	1.07	ND	<5	5	5	-	-
Las Vegas, Nev.	0.90	1.05	ND	<5	2	2	-	-
Little Rock, Ark.	1.20	1.20	ND	<5	16	13	<10	<10
Louisville, Ky.	1.14	1.17	ND	<5	9	8	<10	<10
Manchester, N. H.	1.22	1.22	ND	<5	10	12	<10	35
Memphis, Tenn.	1.22	1.22	ND	<5	14	14	<10	<10
Milwaukee, Wis.	1.20	1.15	ND	<5	5	6	<10	<10
Minneapolis, Minn.	1.04	1.00	ND	<5	8	9	-	-
New Orleans, La.	1.33	1.23	ND	<5	16	16	<10	<10
New York, N. Y.	1.12	1.10	ND	<5	8	10	<10	10
Norfolk, Va.	1.22	1.17	ND	<5	8	9	<10	<10
Oklahoma City, Okla.	1.18	1.15	ND	<5	9	8	<10	<10
Omaha, Nebr.	0.98	1.02	ND	<5	6	8	-	-
Palmer, Alaska	0.97	1.06	ND	<5	9	7	-	-
Philadelphia, Pa.	1.16	1.14	ND	<5	7	9	<10	10
Phoenix, Ariz.	0.98	0.99	ND	<5	3	4	-	-
Pittsburgh, Pa.	1.16	1.21	ND	<5	8	13	<10	10
Portland, Maine	1.15	1.13	ND	<5	8	12	<10	25
Portland, Oreg.	1.10	1.09	ND	<5	8	10	-	-
Providence, R. I.	1.15	1.15	ND	<5	9	13	<10	15
Sacramento, Calif.	1.05	1.04	ND	<5	6	5	-	-
Salt Lake City, Utah	1.08	1.10	ND	<5	6	6	-	-
San Francisco, Calif.	1.04	1.08	ND	<5	2	4	-	-

See footnotes at end of table.

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TABLE 2.--RADIOACTIVITY IN MILK--Con.

Public Health Service Milk Monitoring Program

Processed Milk Area Sampling Stations--September 1960

(Radioactivity in uuc/liter)

Area	Calcium (grams/liter)		Strontium-89		Strontium-90		Cesium-137	
	Sept.	Average to date	Sept.	Average to date	Sept.	Average to date	Sept.	Average to date
San Juan, P. R.	1.16	1.12	ND	< 5	4	4	< 10	< 10
Seattle, Wash.	1.06	1.08	ND	< 5	9	9	-	60
Spokane, Wash.	0.96	1.06	ND	< 5	7	8	-	-
St. George, Utah	1.00	0.98	ND	< 5	6	5	-	-
St. Louis, Mo.	1.06	1.02	ND	< 5	7	6	-	-
Syracuse, N. Y.	1.17	1.22	ND	< 5	6	7	< 10	10
Tampa, Fla.	1.26	1.24	ND	< 5	5	4	86	80
Trenton, N. J.	1.11	1.15	ND	< 5	7	8	< 10	< 10
Washington, D. C.	1.18	1.13	ND	< 5	6	8	< 10	< 10
Wichita, Kans.	1.08	1.08	ND	< 5	6	6	-	-
Wilmington Del.	1.17	1.20	ND	< 5	8	9	< 10	15

ND--No detectable activity.

Because this program was initiated in 1960 and sampling stations necessarily became operative in a staggered sequence, the averages shown represent all samples taken to date. Averages will normally be for the latest 12 month period after sampling began. For the September data, the average covers a period of one to seven months.

SECTION IV.—WATER

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK

The National Water Quality Network was established under the provision of Section 4 (c) of Public Law 660, which states "... the Surgeon General shall ... collect and disseminate basic data ... (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local health agencies, was started in October 1957. At present there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses; some of these stations are interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately a total of 250 to 300 stations will be operated. A few of the more recently established stations have not begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The radioactivity levels of dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the same nuclides being present. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River. The results are reported in micromicrocuries per liter, and are shown for each station on a given river.

While beta determinations for the first two years of the Network operation have been done on each sample weekly, the alpha determinations are reported generally on a composite sample of more than one week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on three-month composite samples, with 1/3 of the stations being covered each month. All the data reported below represent the average of all information available for the month indicated.

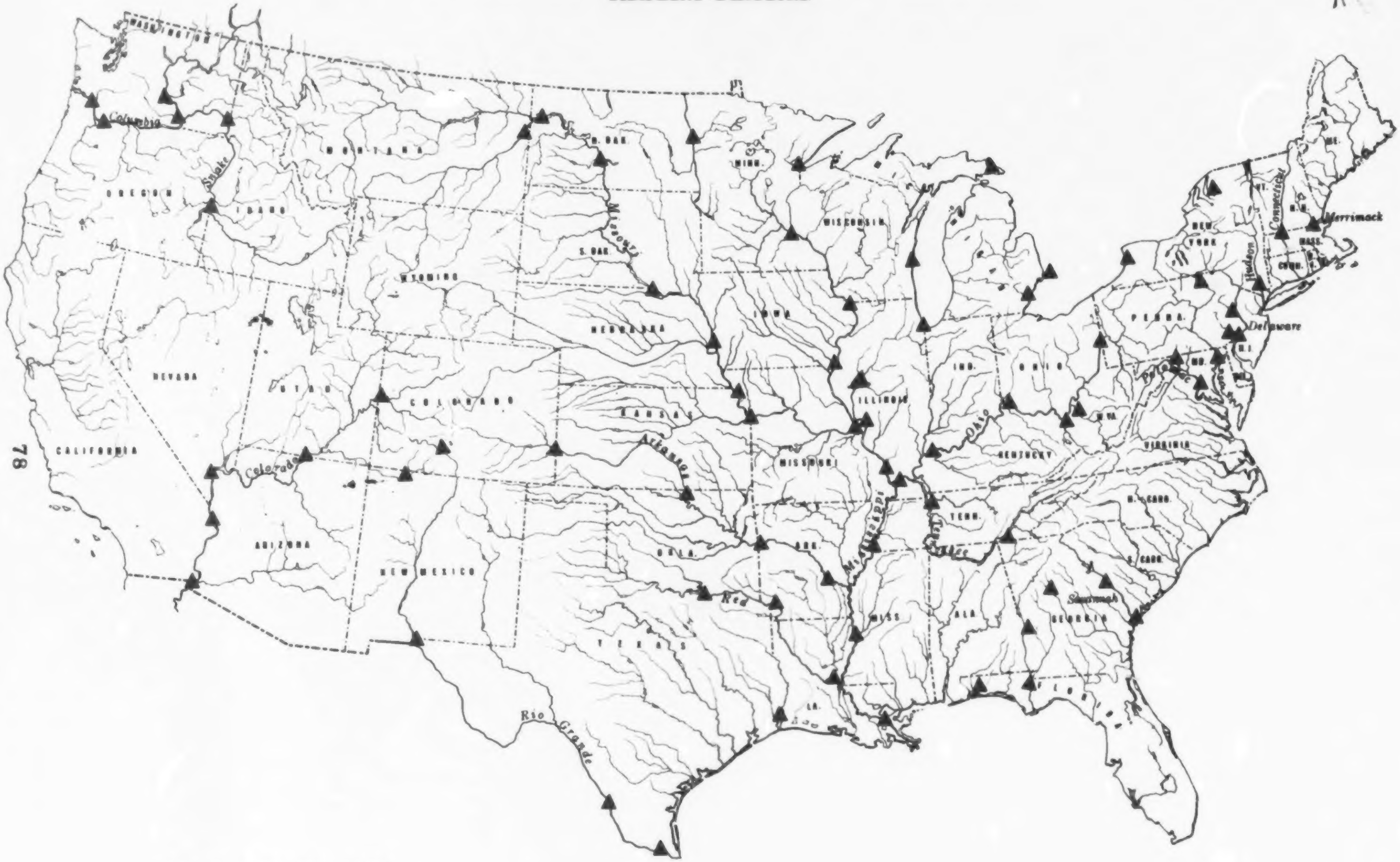
Strontium-90 data are reported as being the results of determinations on composite samples for a three-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

1. "National Water Quality Network Annual Compilation of Data," PHS Publication. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.50.

2. "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, to Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167-169.

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK
SAMPLING STATIONS


WASHINGTON
Columbia
OREGON
Snake
IDAHO
MONTANA
CALIFORNIA
NEVADA
UTAH
WYOMING
COLORADO
Colorado
ARIZONA
NEW MEXICO
N. DAK.
S. DAK.
Missouri
NEBRASKA
KANSAS
Arkansas
OKLA.
Red
TEXAS
Rio Grande
MINN.
IOWA
MISSOURI
ARK.
LA.
WISCONSIN
ILLINOIS
Mississippi
IND.
OHIO
Ohio
KENTUCKY
TENN.
Tennessee
MISS.
ALA.
GEORGIA
Savannah
FLORIDA
S. CARO.
N. CARO.
VIRGINIA
W. VA.
Potomac
MD.
PENNA.
Delaware
NEW YORK
Hudson
Connecticut
VT.
N.H.
ME.
MASS.
CONN.
Merrimack

As of June 30, 1960

FIGURE 1

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TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	August 1960					
		Beta activity			Alpha activity		
	Strontium-90	Susp.	Diss.	Total	Susp.	Diss.	Total
ANIMAS RIVER							
Cedar Hill, N. Mex.	0.3	14	20	34	6	18	24
APALACHICOLA RIVER							
Chattahoochie, Fla.	(*)	0	0	0	0	0	0
ARKANSAS RIVER							
Coolidge, Kans.	1.1	0	0	0	0	26	26
Ponca City, Okla.	1.3	54	2	56	48	4	52
Fort Smith, Ark.	1.1	15	3	18	2	1	3
Pendleton Ferry, Ark.	1.2	14	9	23	14	0	14
CHATTAHOOCHIE RIVER							
Atlanta, Ga.	(*)	0	0	0	1	0	-
Columbus, Ga.	0.5	0	1	1	0	0	0
COLORADO RIVER							
Loma, Colo.	0.3	0	6	6	2	12	14
Page, Ariz.	0.9	69	1	70	26	14	40
Hoover Dam, Ariz.-Nev.	1.3	0	1	1	0	11	11
Parker Dam, Ariz.-Calif.	0.4	-	-	-	-	-	-
Yuma, Ariz.	1.0	0	8	8	<1	16	16
COLUMBIA RIVER							
Pasco, Wash.	0.3	27	276	303	0	0	0
Wenatchee, Wash.	0.3	0	0	0	-	-	-
Bonneville Dam, Oreg.	(*)	16	186	202	-	-	-
Clatskanie, Oreg.	0.3	-	-	-	-	-	-
CONNECTICUT RIVER							
Northfield, Mass.	(*)	1	0	1	-	-	-
DELAWARE RIVER							
Martin's Creek, Pa.	0.4	0	0	0	0	1	1
Philadelphia, Pa.	0.3	0	6	6	3	1	4
GREAT LAKES							
Gary, Ind.	(*)	0	0	0	0	0	0
Duluth, Minn.	0.3	0	0	0	0	0	0
Detroit, Mich.	0.6	<1	0	<1	0	0	0
Buffalo, N. Y.	0.7	4	4	8	1	1	2
Milwaukee, Wis.	-	0	0	0	0	2	2
HUDSON RIVER							
Poughkeepsie, N. Y.	0.7	0	4	4	0	1	1
ILLINOIS RIVER							
Peoria, Ill.	0.8	5	19	24	<1	1	2

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Con.

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	August 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
KANAWHA RIVER							
Winfield Dam, W. Va.	0.3	0	0	0	0	1	1
MISSISSIPPI RIVER							
Red Wing, Minn.	1.5	0	5	5	1	2	3
Dubuque, Iowa	(*)	0	<1	<1	1	3	4
Burlington, Iowa	(*)	1	0	1	0	0	0
East St. Louis, Ill.	1.2	0	2	2	0	3	3
Cape Girardeau, Mo.	0.9	0	0	0	-	-	-
West Memphis, Ark.	0.9	8	10	18	-	-	-
Delta, La.	(*)	0	6	6	1	2	3
New Orleans, La.	1.0	0	0	0	-	-	-
MISSOURI RIVER							
Williston, N. Dak.	0.7	7	5	12	1	7	8
Bismarck, N. Dak.	0.9	-	-	-	-	-	-
Yankton, S. Dak.	1.0	<1	4	4	0	4	4
Omaha, Nebr.	0.6	0	10	10	8	8	16
St. Joseph, Mo.	0.9	15	5	20	5	4	9
Kansas City, Kans.	0.9	11	2	13	2	6	8
St. Louis, Mo.	1.0	0	14	14	-	-	-
OHIO RIVER							
East Liverpool, Ohio	1.9	0	3	3	0	0	0
Wheeling, W. Va.	-	<1	2	2	2	<1	2
Huntington, W. Va.	0.3	0	8	8	1	14	15
Cincinnati, Ohio	0.6	0	2	2	1	0	1
Evansville, Ind.	0.4	1	0	1	-	-	-
Cairo, Ill.	0.7	0	4	4	-	-	-
POTOMAC RIVER							
Williamsport, Md.	0.8	0	0	0	0	1	1
Great Falls, Md.	0.5	2	2	4	0	0	0
RED RIVER							
Denison, Tex.	1.2	0	0	0	1	12	13
Index, Ark.	1.2	0	1	1	1	5	6
Alexandria, La.	0.7	3	0	3	1	3	4
RIO GRANDE RIVER							
El Paso, Tex.	1.4	2	2	4	2	11	13
Laredo, Tex.	1.0	26	11	37	75	4	79
Brownsville, Tex.	0.7	0	0	0	0	8	8
SABINE RIVER							
Ruliff, Tex.	(*)	0	<1	<1	1	0	1
ST. CLAIR RIVER							
Port Huron, Mich.	(*)	0	2	2	0	<1	<1

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Con.

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending June 30, 1960	August 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
ST. LAWRENCE RIVER							
Massena, N. Y.	0.6	0	2	2	0	<1	<1
ST. MARY'S RIVER							
Sault Ste. Marie, Mich.	0.4	6	0	6	0	0	0
SCHUYLKILL RIVER							
Philadelphia, Pa.	0.7	0	24	24	0	1	1
SAVANNAH RIVER							
North Augusta, S. C.	(*)	<1	3	4	1	0	1
Port Wentworth, Ga.	0.8	1	34	35	1	<1	2
SNAKE RIVER							
Wawawai, Wash.	0.3	0	2	2	0	4	4
Weiser, Idaho	0.5	0	7	7	-	-	-
SUSQUEHANNA RIVER							
Sayre, Pa.	0.4	0	0	0	0	0	0
Conowingo, Md.	0.2	0	2	2	0	1	1
TENNESSEE RIVER							
Chattanooga, Tenn.	1.3	0	48	48	0	<1	<1
YELLOWSTONE RIVER							
Sidney, Mont.	0.3	0	4	4	1	8	9

*Insufficient sample for analysis.

SECTION V.—OTHER DATA

EXTERNAL GAMMA ACTIVITY

PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

Portable survey instruments are available at the stations of the Radiation Surveillance Network and one of their uses is to record external gamma radiation. These readings are not precise, especially for measurement of low levels but they can show the presence or absence of any significant increases above background. The differences among the values shown on the following table are within the variance anticipated due to differences in normal background and in instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY

Public Health Service Radiation Surveillance Network

September, 1960

Station location	Average* (mr/hr)	Station location	Average* (mr/hr)
Alaska, Anchorage	0.01	Mississippi, Pascagoula	(**)
Alaska, Fairbanks	0.01	Missouri, Jefferson City	0.01
Alaska, Juneau	0.01	Montana, Helena	0.03
Arizona, Phoenix	0.01	New Jersey, Trenton	0.02
Arkansas, Little Rock	0.01	New Mexico, Santa Fe	0.04
California, Berkeley	0.01	New York, Albany	0.02
California, Los Angeles	0.01	North Carolina, Gastonia	0.02
Colorado, Denver	0.02	Ohio, Cincinnati	(**)
Connecticut, Hartford	0.01	Oklahoma, Oklahoma City	0.02
District of Columbia	0.02	Oklahoma, Ponca City	0.04
Florida, Jacksonville	0.01	Oregon, Portland	0.01
Georgia, Atlanta	0.02	Pennsylvania, Harrisburg	0.01
Hawaii, Honolulu	0.03	Rhode Island, Providence	0.02
Idaho, Boise	0.02	South Carolina, Columbia	0.02
Illinois, Springfield	0.01	South Dakota, Edgemont	(**)
Indiana, Indianapolis	0.01	South Dakota, Pierre	0.02
Iowa, Iowa City	0.02	Texas, Austin	0.01
Kansas, Topeka	0.02	Texas, El Paso	0.02
Louisiana, New Orleans	0.01	Utah, Salt Lake City	0.02
Maryland, Baltimore	0.02	Virginia, Richmond	0.01
Massachusetts, Lawrence	0.02	Washington, Seattle	0.02
Michigan, Lansing	0.02	Wyoming, Cheyenne	0.02
Minnesota, Minneapolis	0.01		

* Readings taken three feet above the ground.
** No data received.

RADIOACTIVE CONTAMINATION OF JET AIRCRAFT

There are three public health aspects of radioactive contamination and radiation exposure associated with jet aircraft.

1. In-flight external exposure of passengers and crew from radioactive particles formed from weapons testing and natural radiation. Measurements indicate that the former has not resulted in any detectable radiation exposure while the latter represents cosmic ray exposure of extra-terrestial origin and is the more significant.

2. In-flight inhalation exposure from air-borne activity in the cabin. Results obtained are similar to air contamination at ground level.

3. External occupational exposure to maintenance personnel working on the aircraft while it is on the ground. During the spring of 1959 when man-made concentrations in air were considerably higher than current concentrations, the major exposure was occupational--but the data indicated this was small.

The following article by Mr. Robert H. Neill, Division of Radiological Health, Public Health Service presents some data on the contamination of jet aircraft.

RADIOACTIVE CONTAMINATION OF JET AIRCRAFT

Division of Radiological Health
Public Health Service

Radioactive contamination of jet aircraft generally results from in-flight accumulation of radioactive particles on the exterior surfaces of the aircraft. These radioactive particles, resulting from nuclear weapons testing, have various residence times in the upper atmosphere before eventually settling to earth in the form of fallout.[1] This contamination is not inherently unique to jet aircraft; it has also been measured on propeller-driven aircraft. Government agencies, including the U. S. Atomic Energy Commission,[2] U. S. Air Force[3] and the Federal Aviation Agency, have studied this question in the past. Exposures may be received from cosmic radiation and the inhalation of cabin air containing fission products and natural radioactive materials.

The atmosphere is divided into the troposphere and stratosphere separated by the tropopause, which varies in height from 50,000 feet at the equator to about 35,000 feet at the poles. That part of a nuclear cloud contained in the troposphere, or area where weather is generated, will exhibit a residence time on the order of a month. Radioactive debris carried into the upper part of the atmosphere or stratosphere will circulate and may exhibit a residence time from less than a year to several years; evidently this is dependent on the height and latitude of detonations.[4]

For aircraft operating below the tropopause, surface contamination would be witnessed only for a relatively short time after a test series. Thus the air concentration would contribute very little to surface contamination of aircraft. With travel at the higher altitudes contamination has been witnessed for a much longer period of time.

Surveys

In cooperation with the Pan-American World Airways system, the Public Health Service obtained measurements from February 1959 to April 1960 to assess radiation exposures to passengers, crew and ground maintenance personnel.

Measurements of beta-gamma radioactivity of the external surfaces of jet aircraft were recorded for a period of over a year. Pan-American routinely surveyed different aircraft on arrival at the New York International Airport. The results showed a tendency for fission product debris to adhere to those surfaces where the air undergoes an abrupt change in direction. A build-up of activity also occurs at the site of oily smears. Similar results have been noted by the British.[5] At the site of the pressurization system air inlet, where airflow undergoes an abrupt change in direction, activity levels are higher. It should be noted here that exposure levels due to external contamination, measured inside the passenger compartment and the cockpit, were similar to those experienced at ground level. Measurements taken on surfaces perpendicular to the air flow, such as the leading edge of a wing where it joins the fuselage, show low readings. This may be due to the air cushioning effect of airflow stagnation at the surface.

[1-5] See references on p. 88-89.

Measurements show that the activity does not appear to build up indefinitely but reaches a state of equilibrium. Data from measurements obtained on selected surfaces from February 1959 to November 1959 have shown levels decreasing more rapidly than would be expected by normal decay. It would seem that weathering, such as flying through rain, assists this process.

Table 1 lists average results of surveys made during the late fall of 1959 on a number of commercial jet aircraft in routing operation. Table 2 presents data on the concentration of radioactive material in the cabin air of commercial and military jet aircraft.

TABLE 1.—TYPICAL RESULTS OF JET AIRCRAFT RADIATION MONITORING

December 1959

Location	Beta and gamma				Gamma	
	mr/hr	cpm	mr/hr	cpm	cpm	cpm
Probe to surface distance	1"	1"	3"	3"	1"	3"
Exterior:						
Forward cabin outflow valve	0.3	1200	0.1	400	100	100
Electronics cooling outlet	1.6	6500	.4	1600	200	100
Center cabin outflow valve	0.6	2500	.2	800	150	100
Interior:						
Forward galley vent	0.02	75	0.20	75	50	50
Grill—aft water tank gage	.02	75	.015	50	50	50

Instrument used: Thyac 389C portable survey meter.
Beta-gamma background—150 cpm.
Gamma background—75 cpm.

TABLE 2.–CONCENTRATIONS OF RADIOACTIVE MATERIALS IN CABIN AIR

Date	From	To	Aircraft	Altitude (feet)	Sampled by	Beta activity ($\mu\mu c/m^3$)	Alpha activity ($\mu\mu c/m^3$)	Analyzed by	Period of Sampling (min)
Oct. 7, 1959	Seattle	Bermuda	Boeing 707	31,000	PHS	No detectable activity	No detectable activity	PHS Cincinnati	120 (power failure)
Dec. 8, 1959	New York	London	Boeing 707	Unknown	AEC	0.06	0.3	AEC, NYOO	Unknown
Mar. 3, 1960	Long Beach	Miami	Douglas DC-8	33,000	PHS	0.7	No det. activity	PHS Cincinnati	250
Fall 1959	Castle AFB over western U.S.		KC-135	41,000	USAF	No det. act.	No det. act.	USAF	45
Fall 1959	Castle AFB over western U.S.		KC-135	42,000	USAF	8.0	0.1	USAF	70
Fall 1959	Castle AFB over western U.S.		KC-135	44,000	USAF	2.96	$9X10^{-3}$	USAF	86
Fall 1959	Castle AFB over western U.S.		KC-135	38,000	USAF	4.87	No det. act.	USAF	90
Fall 1959	Castle AFB over western U.S.		KC-135	32,000	USAF	1.43	$1.3X10^{-2}$	USAF	120
Winter 1960	Clinton-Sherman AFB		B-52	Unknown	USAF	No det. act.	No det. act.	USAF	Unknown

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Mops as a Screening Device

As a means of screening aircraft to determine any unusual increase in external contamination for maintenance personnel working in the vicinity, Pan-American World Airways recorded measurements of activity of the mops used in washing down the exteriors of the aircraft.

To ascertain the type of activity present, one mop was forwarded to the Public Health Service Sanitary Engineering Center in Cincinnati in March 1959 for detailed radioisotopic analysis.

The total activity of the mop was 3.2 microcuries gross beta with a possibility of gross alpha amounting to less than 0.002 microcuries or 0.06 percent of the gross beta.

An initial gamma spectral determination on the mop as received showed prominent activities of Zr^{95}-Nb^{95}, Ru-Rh, and Ce-Pr. The mop was then ashed and the ash divided into acid soluble and acid insoluble fractions. The distribution of gross beta activity was approximately equal in the two fractions, 57 percent being found in the soluble fraction as against 43 percent in the insoluble fraction. On the other hand about 90 percent of the strontium-90 was found in the soluble fraction and only 10 percent in the insoluble fraction. The more prominent gamma emitters (Zr-Nb, Ru-Rh, and Ce-Pr) were found in both the soluble and insoluble fractions. Tungsten-185 was found only in the insoluble fractions and zinc-65 only in the soluble fraction.

The gross activity and strontium-90 values obtained are shown in the following table.

TABLE 3.--MOP GROSS ACTIVITY AND STRONTIUM-90 CONTENT

Fraction	Gross beta (μc/mop)	Gross alpha (μc/mop)	Strontium-90 (μc/mop)
Insoluble	1.37	-	0.003
Soluble	1.83	0.002	0.034
Total	3.20	0.002	0.037

It is not known if in the washing process a solvent was used which would tend to distort the relative values of the soluble and insoluble fraction.

Air Filters

In order to obtain a qualitative picture of the air entering the cabin on a commercial jet carrier, millipore filters were fastened to the auxiliary cabin air inlet on a Boeing 707 in March 1959. This arrangement was not satisfactory as many of the filters tore due to the air pressure, and no way was available to determine the amount of air filtered. The filters were counted for gross beta at the Public Health Service, Division of Radiological Health Laboratory in Washington. Results ranged from background to about 3000 μμc per filter, with most filters averaging a few hundred μμc. These are shown in the following table.

TABLE 4.--RESULTS OF ANALYSES OF MILLIPORE FILTERS FASTENED TO THE CABIN AUXILIARY AIR INLETS OF COMMERCIAL JETS

Aircraft number	Date sample taken (1959)	Radioactivity (gross beta) (μμc)
710	April 1	66
711	April 1	126
711	March 28	104
711	March 30	177
711	March 30	582
710	May 13	450
711	April 16	1148
710	April 16	8
711	April 12	52
711	April 12	2802
710	April 11	540
711		

Air-Water Separators

Eighteen air-water separators from the auxiliary air intake on commercial 707's were analyzed by gamma spectroscopy at the Sanitary Engineering Center in Cincinnati. Results indicated peaks for Zr^{95}-Nb^{95}, $Ru^{103-106}$ and $Ce^{141-144}$ were consistently in the ratio of 6:2:3. Fission product activity of these samples taken in March 1959 indicated an approximate age of about 120 days which would reflect the atmospheric injections of various test series occurring in the fall of 1958.

Decontamination

If necessary the external surfaces of aircraft are cleansed with solvent, then washed with a detergent and water. Pan-American routinely cleaned any surface exhibiting activity of 3 mr/hr beta and gamma. By washing at those levels, the undertaking of a full radiation protection system was not necessary.

Cosmic Radiation Exposure

Cosmic ray exposure results from high energy protons (billions of electron volts) which transfer their kinetic energy to molecules of nitrogen and oxygen in the air to produce secondary particles of positively and negatively charged electrons, mesons and photons. Cosmic rays are generally divided into hard and soft components. The soft component represents that which is absorbed in 10 centimeters of lead. The secondary particles are associated with this.

Table 5 is intended to illustrate some relative approximate doses for different latitudes and altitudes. Assumptions in the calculation for absorbed doses include:

(1) exposures at various sites with no shielding,

(2) similar biological response for all types of radiation,

(3) equivalent absorption in soft tissue using 2.08×10^9 ion pairs (i.p.) per cc of air per roentgen, and

(4) an absorbed dose from 200 Mev particles (average energy of secondaries) being similar to that from lower energy particles.

Exposure to cosmic rays at 40,000 feet altitude in the temperate latitudes for 80 hours/month* may double the radiation dose that might be received from the average total background radiation of 125 mrem estimated at sea level.[6]

The latitude effect reflects minimal values at the equator rising to a peak in the north and south temperate latitudes and is reminiscent of the observed latitudinal variation in Sr^{90} deposition from weapons testing (the causal mechanisms of both curves are different).

With increased commercial air travel contemplated at altitudes in excess of 80,000 feet, it appears that this source of exposure to man requires more study to determine its significance. Such questions--regarding the increase in secondaries from attenuation in the aircraft skin, the relative biological effect for these particles of 200 Mev intensity, and the biological effects of positive pi mesons which decay before reaching the earths surface--need to be answered.

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[6] See references on p. 89.

TABLE 5.--ESTIMATE OF COSMIC RAY EXPOSURE

Latitude	Altitude (feet)	i.p./cc air/sec[7,8]	Length of exp./yr.	Sec/yr.	i.p./cc air/yr.	mrem/yr. (soft tissue)
All lat...	Sea level	2	12 mo./yr.	3.15×10^7	6.3×10^7	30
All lat...	10,000	10	12 mo./yr.	3.15×10^7	3.15×10^7	150
40° N....	40,000	200	*80 hrs./mo.	3.4×10^6	6.8×10^8	328
40° N....	54,000	260	80 hrs./mo.	3.4×10^6	8.8×10^8	425
3° N......	54,000	90	80 hrs./mo.	3.4×10^6	3.1×10^8	147

[7, 8] See references on p. 89.

*Standard flight time of U. S. aircarrier crews.

Table 5 is predicated on an equivalent absorption in soft tissue using 2.08×10^9 ion pairs per cc of air per roentgen. Although the energy absorbed in people varies considerably with the type of particle being considered and the possibility of additional secondary particles being formed while passing through the aircraft, the table is intended to serve as a rough approximation to illustrate this exposure to cosmic ray radiation.

This increase in external radiation from natural background, including extraterrestial or cosmic activity, was recorded on March 17, 1960, in a DC-8 both during the ascent at Long Beach, California, and the descent over Miami, Florida, using a Thyac 389C Serial No. 930 portable field survey instrument. The readings are recorded in table 6.

TABLE 6.--BETA-GAMMA ACTIVITY DURING AIRCRAFT ASCENT AND DESCENT--MARCH 17, 1960

Ascent at Long Beach		Descent at Miami	
Altitude (feet)	Activity (mr/hr)	Altitude (feet)	Activity (mr/hr)
0	0.01	33,000	0.20
2,000	0.02	32,500	0.12
4,000	0.02	30,000	0.13
5,000	0.03	29,000	0.11
6,000	0.02	28,000	0.10
8,000	0.03	25,000	0.08
10,000	0.025	24,000	0.08
12,000	0.030	18,000	0.05
14,000	0.03	17,000	0.03
16,000	0.035	16,000	0.03
18,000	0.040	14,000	0.03
20,000	0.05	10,000	0.02
21,000	0.05	9,000	0.02
23,000	0.09	4,000	0.01
24,000	0.08	2,000	0.01
26,000	0.09	0	0.01
27,500	0.10		
28,000	0.09		
29,000	0.11		
30,000	0.11		
32,000	0.15		
32,500	0.16		
33,100	0.20		

Readings of 0.4 mr/hr were recorded at 31,000 feet on October 17, 1959, on a flight from Seattle to Bermuda in a Boeing 707. The readings of 0.4 mr/hr cannot be related to dose due to the energy response characteristic of the instrument and the secondary particle energy spectrum which is measured at altitudes in excess of 30,000 feet. An average reading would be 1600 dpm using a geiger tube instrument with a window thickness of 30 mg/cm^2.

From the data of Millikan, Neher and Pickering, reported in Physical Review, 61,397 (1942), the cosmic ray intensity is 135 ions/cc air/sec at an altitude of 35,000 feet in the northern United States (latitude greater than 40°). For an individual flying 80 hours per month at this altitude it would amount to 0.46×10^9 ion/cc/yr. This would amount to an exposure dose of 220 milliroentgens per year. Thus it may be seen that the major radiation exposure during commercial jet aircraft travel is not from fission product exposure but from cosmic or natural radioactivity.

References

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3. "Aircraft Contamination from Residual Stratospheric Nuclear Weapon Debris," Report TN-59-5, USAF Special Weapons Project, July 1959.

4. "Analysis of Stratospheric Sr^{90} Measurements," L. Machta and R. J. List, U. S. Weather Bureau. Congressional Hearings on Fallout from Nuclear Weapons Tests, Joint Committee on Atomic Energy, May 1959, Vol. I, p. 742.

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OFF-SITE ANIMAL INVESTIGATION PROJECT*

Atomic Energy Commission

In 1957, the AEC inaugurated an "Off-Site Animal Investigation Project." This consisted of establishing and maintaining a herd of about 45 Hereford cattle on the Nevada Test Site in Nevada. The objective of the project was to enhance the NTS off-site/rancher relationship through an active project in their interests, and further to provide information as to the status of the off-site animals in their environment, with special interest on the radioactive isotope uptake from fallout. Periodically animals representing both sexes and the various age groups were sacrificed. The herd is moved to allow the cattle to forage in areas where there is a maximum availability of fission products.

In 1958 the University of Nevada which maintained similar herds located at Caliente, Nevada (Delamar Valley = DV) and at Contact, Nevada (Knoll Creek = KC), under its contract with the Atomic Energy Commission's Division of Biology and Medicine, altered its sacrificing schedule to coincide with those of the NTS herds. Five animals from each of the three herds are sacrificed twice yearly. The animals lost through sacrificing have generally been replaced by calves.

Several laboratories cooperate in conducting analyses for the various radionuclides as follows:

Iodine-131—University of Tennessee and University of Nevada
Strontium-90—Health and Safety Laboratory, Atomic Energy Commission
Gamma scan—Los Alamos Scientific Laboratory
Cesium-137—Reynolds Electrical and Engineering Company, Inc.
Plutonium—University of California at Los Angeles, Atomic Energy Project
Pathological Examination—Armed Forces Institute of Pathology

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*Summarized from Second and Third Annual Report, entitled "Off Site Animal Investigation Project," by Major Garland Farmer, VC, U. S. Army, Office of Test Operations, Atomic Energy Commission, Las Vegas Nevada.

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TABLE 1.—DATA ON SACRIFICED ANIMALS

Code number	Area	Date sacrificed	Age	Sex	Weight (lb.)
B-22-57	NTS	Nov. 29, 1957	6 mo.	M	-
B-23-57	NTS	Dec. 2, 1957	1 yr.	F	-
B-24-57	NTS	Dec. 2, 1957	6 mo.	M	-
B-25-57	NTS	Dec. 4, 1957	1 yr.	F	-
B-34-57	NTS	Dec. 12, 1957	7 yr.	F	-
B-27-57	DV	Dec. 5, 1957	1 yr.	M	-
B-28-57	DV	Dec. 6, 1957	9 yr.	F	-
B-29-57	DV	Dec. 6, 1957	6 mo.	M	-
B-30-57	DV	Dec. 6, 1957	1 yr.	M	-
B-31-57	DV	Dec. 9, 1957	9 yr.	F	-
B-32-57	DV	Dec. 9, 1957	6 mo.	F	-
B-8-58	KC	May 20, 1958	Aged	F	-
B-9-58	KC	May 20, 1958	1 yr.	-	-
B-10-58	KC	May 20, 1958	1 mo.	-	-
B-11-58	DV	May 27, 1958	Aged	F	-
B-12-58	DV	May 27, 1958	1 yr.	-	-
B-13-58	DV	May 27, 1958	3 mo.	-	-
B-14-58	NTS	June 2, 1958	1 yr.	-	-
B-15-58	NTS	June 3, 1958	2 yr.	-	-
B-16-58	NTS	June 3, 1958	Aged	F	-
B-17-58	NTS	June 3, 1958	1 mo.	-	-
B-18-58	KC	Nov. 6, 1958	5 yr. 6 mo.	F	930
B-19-58	KC	Nov. 6, 1958	2 yr. 6 mo.	F	920
B-20-58	KC	Nov. 6, 1958	1 yr. 6 mo.	M	430
B-21-58	KC	Nov. 6, 1958	10 da.	M	90
B-22-58	DV	Nov. 14, 1958	Aged	F	670
B-23-58	DV	Nov. 14, 1958	2 yr. 6 mo.	M	635
B-24-58	DV	Nov. 14, 1958	1 yr. 7 mo.	M	390
B-25-58	DV	Nov. 14, 1958	5 mo.	M	245
B-26-58	NTS	Nov. 21, 1958	Aged	F	880
B-27-58	NTS	Nov. 21, 1958	2 yr.	F	700
B-28-58	NTS	Nov. 21, 1958	1 1/2 yr.	F	650
B-29-58	NTS	Nov. 21, 1958	7 mo.	M	275
B-30-58	NTS	Apr. 23, 1959	Aged	F	790
B-31-58	NTS	Apr. 23, 1959	2 yr. 6 mo.	M	750
B-32-59	NTS	Apr. 23, 1959	1 yr. 10 mo.	M	670
B-33-59	NTS	Apr. 23, 1959	1 mo.	M	110
B-34-59	DV	Apr. 30, 1959	Aged	F	750
B-35-59	DV	Apr. 30, 1959	2 yr.	F	475
B-36-59	DV	Apr. 30, 1959	1 yr.	M	325
B-37-59	DV	Apr. 30, 1959	3 wk.	M	95
B-38-59	KC	May 7, 1959	6 yr.	F	1,115
B-39-59	KC	May 7, 1959	2 yr.	F	490
B-40-59	KC	May 7, 1959	1 yr.	M	430
B-41-59	KC	May 7, 1959	3 mo.	M	255
B-45-59	DV	Nov. 3, 1959	10 yr.	F	720
B-46-59	DV	Nov. 3, 1959	3 yr.	F	505
B-47-59	DV	Nov. 3, 1959	2 yr.	F	630
B-48-59	DV	Nov. 3, 1959	1 yr.	M	370
B-49-59	DV	Nov. 3, 1959	8 mo.	M	180
B-50-59	NTS	Nov. 12, 1959	Aged	F	750
B-51-59	NTS	Nov. 12, 1959	2 yr.	M	950
B-52-59	NTS	Nov. 12, 1959	3 yr.	M	900
B-53-59	NTS	Nov. 12, 1959	1 yr.	M	350
B-54-59	NTS	Nov. 12, 1959	5 mo.	M	180
B-55-59	KC	Nov. 19, 1959	10 yr.	F	970
B-56-59	KC	Nov. 19, 1959	3 yr.	F	775

TABLE 1.--DATA ON SACRIFICED ANIMALS--Con.

Code number	Area	Date sacrificed	Age	Sex	Weight (lbs.)
B-57-59	KC	Nov. 19, 1959	2 yr.	F	1,000
B-58-59	KC	Nov. 19, 1959	1 yr.	M	580
B-59-59	KC	Nov. 19, 1959	5 mo.	M	170
B-60-60	DV	Apr. 22, 1960	4 yr.	F	665
B-61-60	DV	Apr. 22, 1960	3 yr.	F	625
B-62-60	DV	Apr. 22, 1960	2 yr.	F	380
B-63-60	DV	Apr. 22, 1960	1 1/4 yr.	F	220
B-64-60	DV	Apr. 22, 1960	1 mo.	F	75
B-65-60	NTS	Apr. 29, 1960	5 yr.	F	680
B-66-60	NTS	Apr. 29, 1960	3 yr.	M	850
B-67-60	NTS	Apr. 29, 1960	2 yr.	M	450
B-68-60	NTS	Apr. 29, 1960	1 yr.	F	300
B-69-60	NTS	Apr. 29, 1960	3 wks.	F	80
B-70-60	KC	May 7, 1960	6 yr.	F	965
B-71-60	KC	May 7, 1960	3 yr.	F	900
B-72-60	KC	May 7, 1960	2 yr.	F	790
B-73-60	KC	May 7, 1960	1 yr.	F	463
B-74-60	KC	May 7, 1960	2 mo.	F	160

The following tables present the analytical data collected from samples taken from animals in the three herds.

TABLE 2.—IODINE-131 DATA

Code number	I^{131} content of thyroid tissue at time of death (μμc/gm)	Code number	I^{131} content of thyroid tissue at time of death (μμc/gm)
B-18-58	4,420	B-30-59	40
B-19-58	4,490	B-31-59	10
B-20-58	5,870	B-32-59	8
B-21-58	7,550	B-33-59	8
B-38-59	25	B-60-60	15
B-39-59	18	B-61-60	08
B-40-59	7	B-62-60	16
B-41-59	23	B-63-60	20
B-22-58	5,890	B-64-60	12
B-23-58	6,500	B-65-60	12
B-24-58	9,980	B-66-60	13
B-25-58	8,160	B-67-60	15
B-34-59	20	B-68-60	19
B-35-59	30	B-69-60	10
B-36-59	10	B-70-60	3
B-37-59	8	B-71-60	5
B-26-58	7,350	B-72-60	3
B-27-58	124,560	B-73-60	2
B-28-58	156,540	B-74-60	2
B-29-58	161,770		

TABLE 3.—STRONTIUM-90 BONE DATA

Code number	Type bone	Percent Ca in ash	uuc/gm Ca
B-22-57	Proximal 1/3 of femur	36.8	19.3
	Eighth coste chondral jct	34.5	32.3
B-23-57	Proximal 1/3 of femur	37.4	11.8
	Eighth coste chondral jct	35.8	10.1
B-24-57	Proximal 1/3 of femur	37.2	10.2
	Eighth coste chondral jct	39.8	9.2
B-25-57	Proximal 1/3 of femur	36.7	13.0
	Eighth coste chondral jct	35.6	13.2
B-34-57	Proximal 1/3 of femur	38.1	15.1
	Eighth coste chondral jct	37.1	13.4
B-27-57	Proximal 1/3 of femur	37.3	14.4
	Eighth coste chondral jct	35.6	17.6
B-28-57	Proximal 1/3 of femur	38.1	10.8
	Eighth coste chondral jct	35.6	9.4
B-29-57	Proximal 1/3 of femur	35.7	15.0
	Eighth coste chondral jct	35.8	24.0
B-30-57	Proximal 1/3 of femur	35.3	16.6
	Eighth coste chondral jct	33.8	16.5
B-31-57	Proximal 1/3 of femur	38.0	5.6
	Eighth coste chondral jct	38.2	7.0
B-32-57	Proximal 1/3 of femur	37.8	17.8
	Eighth coste chondral jct	37.5	18.9
		gm Ca/kg orig. matl.	
B-18-58	Rib	27.9	15.6
	Femur	5.1	11.6
	Duplicate femur	5.6	19.2
B-19-58	Rib	21.1	26.3
	Femur	5.6	19.4
B-20-58	Rib	27.2	10.7
	Femur	11.0	34.5
B-21-58	Rib	24.6	23.7
	Femur	26.3	14.8
B-8-58	Rib	26.2	14.3
	Femur	4.7	28.9
	Triplicate femur	4.7	17.2
	Triplicate femur	4.5	19.9
B-9-58	Rib	46.8	4.5
	Femur	10.8	37.9
B-10-56	Rib	21.7	18.2
	Femur	25.0	7.0
B-11-58	Rib	37.4	6.8
	Femur	7.3	3.9
B-12-58	Rib	42.2	30.0
	Femur	8.6	21.0
	Duplicate femur	8.6	27.8
B-13-58	Rib	27.1	16.0
	Femur	27.2	18.3
B-22-58	Rib	25.3	8.8
	Femur	6.5	9.3
B-23-58	Rib	29.0	14.1
	Femur	6.8	12.7
B-24-58	Rib	33.4	9.8
	Femur	13.5	14.8
B-25-58	Rib	24.2	5.8
	Femur	14.2	20.4

TABLE 3.—STRONTIUM-90 BONE DATA—Con.

Code number	Type bone	gm Ca/kg orig. matl.	μμc/gm Ca
B-26-58	Rib	17.3	6.4
	Femur	9.4	15.4
	Duplicate femur	9.7	17.2
B-27-58	Rib	23.4	3.8
	Femur	6.2	18.5
B-28-58	Rib	28.0	8.5
	Femur	6.9	28.2
	Duplicate femur	6.9	29.3
B-29-58	Rib	13.9	10.8
	Femur	13.6	44.8
B-14-58	Rib	22.2	3.7
	Femur	11.7	7.2
B-15-58	Rib	43.8	7.3
	Femur	7.2	19.8
B-16-58	Rib	-	8.2
	Femur	-	9.6
B-17-58	Rib	55.3	15.2
	Femur	7.4	27.9

TABLE 4.—STRONTIUM-90 IN RUMEN

Code number	gm Ca/kg orig. matl.	μμc/gm Ca
B-22-57	7.0	333
B-23-57	4.8	473
		453
B-24-57	5.5	566
B-25-57	10.7	221
		221
B-27-57	9.6	144
B-28-57	5.9	86
B-29-57	4.2	192
B-30-57	7.0	134
B-31-57	11.4	67
B-32-57	10.3	77
B-34-57	6.3	600

Code number	gm Ca/kg orig. sample	μμc/kg orig. sample	μμc/gm Ca
B-8-58	5.0	817	163
B-9-58	3.8	579	154
B-10-58	10.1	2,000	200
B-11-58	3.8	272	72.0
B-12-58	3.4	266	78.9
B-13-58	9.4	166	17.7
B-17-58	15.4	1,160	75.3
B-18-58	4.3	924	215
B-19-58	5.5	1,340	244
B-20-58	4.6	1,070	235
B-22-58	14.6	1,200	82.2
B-23-58	30.9	1,020	33.0
B-24-58	12.5	488	39.0
B-25-58	15.5	1,140	73.5
B-26-58	10.8	730	67.6
B-27-58	7.3	1,310	180
B-28-58	9.9	1,760	177
B-29-58	5.5	1,153	209

TABLE 5.—STRONTIUM-90 IN FECES

Area	Date	gm Ca/kg orig. matl.	μμc/kg orig. matl.	μμc/gm Ca
NTS	1957	16.0	-	581 623
DV	1957	33.0	-	111 95
DV	Nov. 21, 1958	21.0	1,160	55
NTS Well No. 3	Jan. 27, 1959	19.8	3,830	193
KC	Nov. 1958	6.5	2,130	329
KC	May 20, 1958	31.7	2,530	80
DV	May 27, 1958	26.7	1,653	62
NTS Area 13	June 3, 1958	28.9	5,480	190

Gamma ray spectrometry was conducted on ashed rumen and fecal samples, for May 1958 and for November 1958.

TABLE 6.—GAMMA RAY SPECTROMETRY

Code number	Sample	mμc/kg original material			
		Zr^{95}	Nb^{95}	Ce^{144}	Ru^{106}
B-8-58	Rumen	21	42	20	1.3
B-9-58	Rumen	18	32	20	1.4
B-10-58	Rumen	56	110	80	4.4
B-11-58	Rumen	1.5	2.8	2.5	0.2
B-12-58	Rumen	1.6	3.2	3.5	0.2
B-13-58	Rumen	12	25	15	1.2
B-17-58	Rumen	43	88	62	6.2
B-24-58	Rumen	50.7	101	37.4	2.2
B-25-58	Rumen	68.3	136	48.6	3.5
B-22-58	Rumen	54.9	109	28.2	2.3
B-23-58	Rumen	55.3	111	45.6	2.5
B-28-58	Rumen	243	488	142	13.8
B-29-58	Rumen	206	415	121	11.7
B-26-58	Rumen	181	364	107	13.4
B-27-58	Rumen	226	454	167	13.8
B-19-58	Rumen	23.6	47.8	32.4	1.6
B-20-58	Rumen	24.8	49.5	32.2	1.9
B-18-58	Rumen	20.6	41.2	27.7	1.7
DV-1-58	Fecal	47	93	43	3.2
NTS-1-58	Fecal	20	39	37	1.8
KC-1-58	Fecal	50	100	56	3.1
DV-2-58	Fecal	15.9	31.6	23.3	1.4
NTS-2-58	Fecal	366	745	250	22.8

NOTE: Fecal samples are from areas indicated, not from individual animals.

TABLE 7.—RADIOACTIVITY OF TISSUE

Sample	Date	gmK/kg orig. matl.	Cs^{137}		Zr^{65} μμc/kg orig. matl.	Other
			μμc/gmK	μμc/kg orig. matl.		
NTS Muscle................	Dec. 1957	3.9	100	390	None	
DV Muscle.................	Dec. 1957	3.8	93	350	None	
Muscle—3 herds pooled	May 1958	3.9	120	470	None	
Liver—3 herds pooled..	May 1958	-	-	230	-	Tr. Zr^{95}, $RuRh^{103-106}$
Bone—3 herds pooled....	May 1958	-	-	None	-	Tr. $BaLa^{140}$, Zr^{95}
Muscle—3 herds pooled	Nov. 1958	4.7	160	770	140	} $RuRh^{103-106}$, Zr^{95}
Liver—3 herds pooled..	Nov. 1958	5.2	68	350	323	
Bone—3 herds pooled....	Nov. 1958	Tr.	Tr.	Tr.	Tr.	$BaLa^{140}$, $3x10^4$ μμc/kg, Tr. Zr^{95}

Tr. = Trace.

TABLE 8.—PLUTONIUM ANALYSIS

Code number	Type sample	dpm/gm bone ash	Code number	Type sample	dpm/gm bone ash
B-8-58....	Rib	0.02	B-13-58..	Rib	Bkg
	Femur	0.01		Femur	0.03
B-9-58....	Rib	0.02	B-14-58..	Rib	0.07
	Femur	0.05		Femur	Bkg.
B-10-58..	Rib	0.03	B-15-58..	Rib	Bkg.
	Femur	0.03		Femur	Bkg.
B-11-58..	Rib	0.08	B-16-58..	Rib	Bkg.
	Femur	0.09		Femur	0.02
B-12-58..	Rib	0.04	B-17-58..	Rib	0.02
	Femur	0.04		Femur	0.03

Note: Rib includes distal 1/3 of rib and coste-chondral junction.
Femur includes 1/3 of shaft and head.

In referring to the iodine data presented in table 1, it should be noted that levels of iodine are consistently low except for the period of Hardtack II Operation (Fall 1958). Taking the body-thyroid weight ratio of the animal, it is found that a 0.7 microcurie level, which constitutes a maximum permissible limit (NBS Handbook 69), is present in the NTS herd three weeks after the end of the Operation. The source of this iodine has been questioned since it is not believed that such an amount was present from surface or altitude shots; hence, there is speculation as to its origin. One explanation advanced was the volatile gases, including I^{131}, from sub-surface shots permeated the earth above the shot point. The gases were then carried by down-drafts to the valley floor where the plant life scavenged the iodine from the air. This is questionable due to the reactive nature of iodine. The amount of iodine observed would require an explanation other than that from altitude shots only. However, it illustrates the point that biological monitoring may be more sensitive to certain isotopes than the mechanical monitors used. Nevertheless, only the NTS herd was above the human MPL, but not by a large factor. Considering that these cattle were not exposed continuously to these levels but only shortly thereafter (note very low May 1959 levels), biological effects are improbable.

The levels of strontium-90 found at the NTS are not significantly higher than the other two off-site areas. The difference in the Sr/Ca ratio between rib and femur in the 1957 data is very small; however, in the 1958 data, the differences become considerably larger (the extreme case is B-9-58, where the rib to femur ratio is 8.5). This seems unreasonable from a biological point of view, although the blind duplicates and triplicates agree quite well. The results of averaging the herds on a yearly basis are as follows:

Herd	Date sacrificed	Av. μμc Sr^{90}/gm Ca
NTS....................	November-December 1957	14.7
DV......................	December 1957	14.5
NTS....................	May-November 1958	14.8
DV......................	May-November 1958	13.9
KC......................	May-November 1958	18.8

All values are essentially the same, and there seems to be no dependence of the strontium to calcium ratio on herd location or year. Possibly the Knoll Creek herd is an exception, showing somewhat higher strontium to calcium ratios because it is on the Nevada-Idaho border where stratospheric fallout is greater.

All reports which have been returned from the Armed Forces Institute of Pathology indicate nothing significant from the microscopic pathological examination. To date, there has been no gross effect observed. Their reproduction rate is normal and the animals maintain themselves in a satisfactory state. There have been no diseased conditions in the herd which would suggest ill health or substandard resistance. Since there have been no weapons tests and subsequent release of fallout material, the uptake of isotopes has been negligible. After three years, it may be concluded that there has been no noticeable radiation damage to this herd. The project remains of interest to the local ranchers who inquire closely about the welfare of the herd. It serves a very useful purpose in furthering Test Site-rancher understanding and relations. It is felt that it is quite important to continue the herd and project, even though tests have ceased, as this will enable a base line of isotope uptake to be established for future reference.

HUMAN BONE SAMPLING PROGRAM OF THE CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM

Human bone samples have been collected and analysed for strontium-90 since 1957 by various pathology departments cooperating in the program of the Radiation Protection Division, Department of National Health and Welfare, Dominion of Canada.

Although many of the samples are autopsy specimens of persons who died of diseases, it is believed that the experimental data will provide a better measure of the potential health hazard from strontium-90 than milk values because the effect of strontium-90 on the body results principally from the amount retained in bone.

More detailed discussion of the sampling procedures, method of analysis, and interpretation of results of the Department's radioactive fallout program is contained in the "Annual Report for 1959," Report Number CNHW (RP-3). The data tables and conclusions from this report are reproduced on the following pages by permission of the above Division of the Canadian Government.

Conclusions

1. The results of total beta particle measurements in precipitation samples collected from a small network during the first half of 1959 indicate that the deposition of radioactive fission products reached a peak in the second quarter of 1959. The results of total beta particle measurements in both air and precipitation samples collected from a larger nation-wide network of stations indicate that the deposition of radioactive fission products decreased considerably in the last half of 1959.
2. The results of the measurement of strontium-90 in milk powder samples indicate that the average level reached a peak in June 1959, decreasing sharply to a minimum in September, followed by an apparent increase again towards the end of the year. The overall increase was about the same as that for 1958.
3. The results of the measurement of strontium-90 in human bone samples show that as expected the level is higher in children than in adults. There is some evidence in favor of a non-uniform distribution of strontium-90 by bone type in adults and of a uniform distribution in children. Calculated levels of strontium-90 in adults using the 1958 ICRP data are in remarkably good agreement with experimental results.

The levels of strontium-90 in bone samples collected during 1957 and 1958, from both adults and children, were well below the maximum permissible recommended by the ICRP. Calculations indicate that this situation will still apply for 1959 and 1960 bones.

FIGURE I

HUMAN BONE DATA, 1957 and 1958

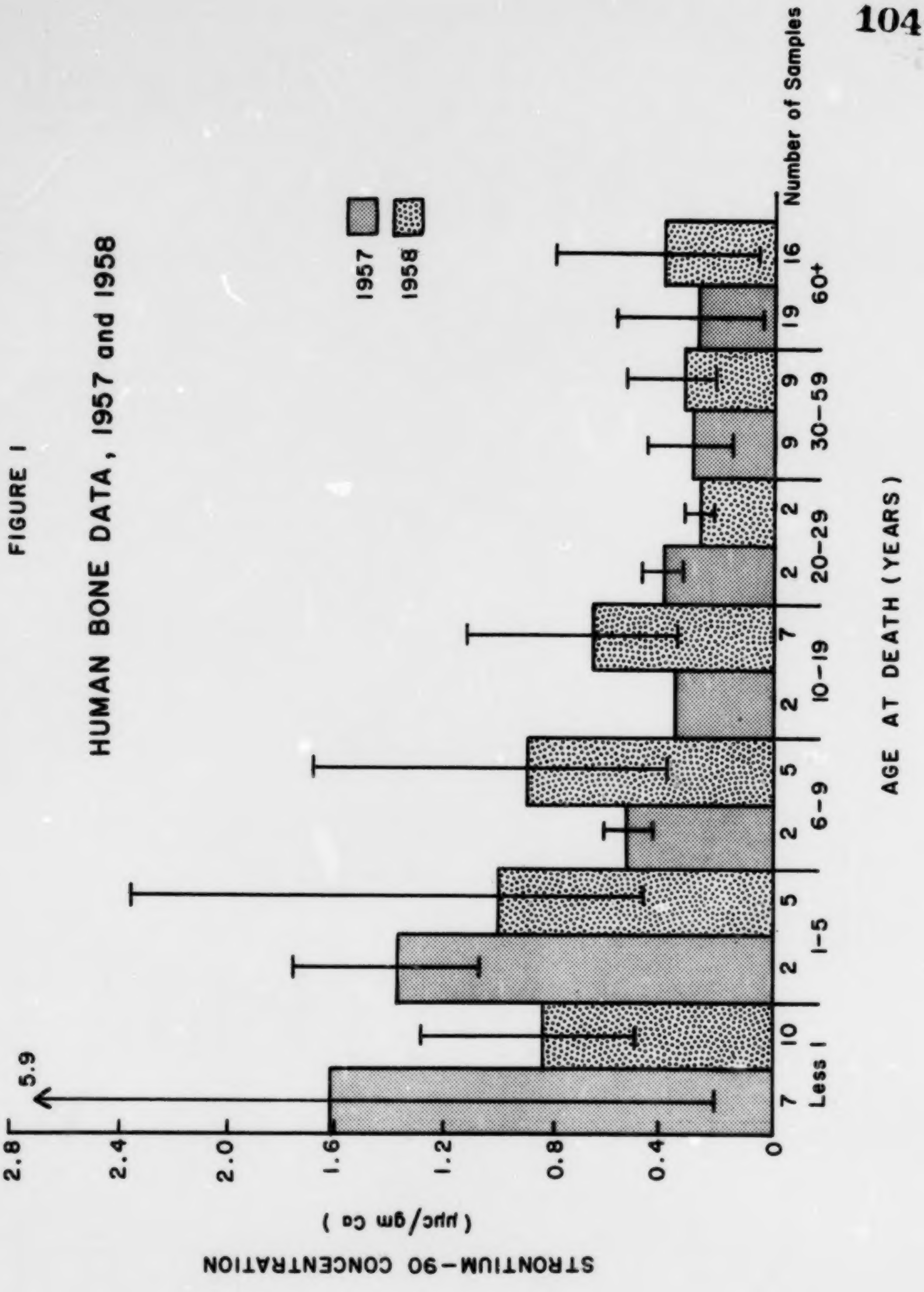

TABLE 1.—HUMAN BONE DATA 1957

(Strontium-90 content per gram of calcium)

Location	Bone type	Age at death (assumed to have occurred in 1957)						
		0-12 mo	1-5 yr	6-9 yr	10-19 yr	20-29 yr	30-59 yr	60+ yr
		μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa
Edmonton	Vertebrae					0.47	0.45	0.58 0.28
	Rib					0.32		0.42
Montreal	Vertebrae						0.27(3) 0.29 0.34	0.39(1) 0.39(2) 0.31
	Rib			0.44				0.39(2)
	Long bone						0.08(3)	0.10(1)
	Miscellaneous							0.23(1) 0.10
Ottawa	Rib						0.33(4) 0.05(4)	0.24(5)
	Long bone						0.12(4) 0.14(4)	
	Miscellaneous						0.22(4)	0.10(5) 0.22(5) 0.06(5)
Regina	Vertebrae	0.42(6)						0.51
	Rib							0.24
	Long bone							0.09 0.17
	Miscellaneous	0.76(6)						0.19 0.06 0.26
Saskatoon	Vertebrae						0.20 0.45	0.58

TABLE 1.–HUMAN BONE DATA 1957–Con.

(Strontium-90 content per gram of calcium)

Location	Bone type	Age at death (assumed to have occurred in 1957)						
		0-12 mo	1-5 yr	6-9 yr	10-19 yr	20-29 yr	30-59 yr	60+ yr
		uuc/gmCa	uuc/gmCa	uuc/gmCa	uuc/gmCa	uuc/gmCa	uuc/gmCa	uuc/gmCa
Toronto	Vertebrae	2.37 5.9		0.62				
	Long bone				0.34(7) 0.23(7)			
	Miscellaneous	0.86 0.21 0.97 0.36	1.78 1.10		0.37 0.51(7)			
Victoria	Rib						0.18	0.31
	Miscellaneous							0.04
Winnipeg	Long bone						0.38	0.32
Average all bones		1.61	1.44	0.53	0.36	0.40	0.29	0.28
Number of subjects		7	2	2	2	2	9	19

Notes: All results with the same bracketed superscript numbers are for specimens from the same body.
Averages are obtained after first obtaining averages for each subject.

TABLE 2.–HUMAN BONE DATA 1958

(Strontium-90 content per gram of calcium)

Location	Bone type	Age at death (assumed to have occurred in 1958)						
		0-12 mo	1-5 yr	6-9 yr	10-19 yr	20-29 yr	30-59 yr	60+ yr
		μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa
Charlottetown	Vertebrae			1.04(8)	0.94(10)	0.37(9)		
	Miscellaneous			0.69(8)	0.41 0.88(10)	0.26(9)		
Edmonton	Long bone						0.33	
Montreal	Vertebrae							0.32
Ottawa	Vertebrae			1.71	1.13 0.57		0.38 0.22 0.32 0.29 0.32	0.48 0.82 0.14 0.53 0.66 0.59 0.44 0.40
	Rib						0.26 0.54	
	Long bone							0.13 0.07
	Miscellaneous							0.31
Sidney	Miscellaneous	1.30						
Toronto	Vertebrae	0.56 0.80 0.68 1.05 1.13 0.63 0.69	0.53(11) 0.45 0.50(13) 0.95	0.55(14)	0.58(12) 0.78			

TABLE 2.—HUMAN BONE DATA 1958—Con.

(Strontium-90 content per gram of calcium)

Location	Bone type	Age at death (assumed to have occurred in 1958)						
		0-12 mo	1-5 yr	6-9 yr	10-19 yr	20-29 yr	30-59 yr	60+ yr
		μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa	μμc/gmCa
Toronto	Rib		0.58(^{11}) 0.47(^{13}) 2.30(^{15})	0.59(^{14}) 0.39	0.42(^{12})			
	Long bone		2.40(^{15})		0.46(^{12})			
	Miscellaneous	0.51 1.10	1.15(^{11})					
Winnipeg	Vertebrae				0.36	0.21	0.34	0.12 0.71 0.65 0.41
	Long bone		0.95(^{16}) 1.04(^{16})					
Average all bones		0.84	1.00	0.91	0.66	0.26	0.33	0.42
Number of subjects		10	5	5	7	2	9	16

Notes: All results with the same bracketed superscript numbers are for specimens from the same body.
Averages are obtained after first obtaining averages for each subject.

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LONG TERM TRAINING ACTIVITIES OF THE DIVISION OF RADIOLOGICAL HEALTH

Public Health Service

Training activities of the Division of Radiological Health Training Branch related to the development and implementation of effective Federal, State and local radiological health services differ considerably from the short-term training courses described in November 1960 Radiological Health Data. These activities pertaining to formal academic training may be classified into three areas: "Outside-Service" Training, Training Grants, and University Liaison Services.

"Outside-Service" Training involves selection and assignment of Commissioned Corps and Civil Service officers for one or more years of full-time graduate study in radiation biology and other curricula related to radiological health. In its current program to qualitatively and quantitatively improve staff competency, the Public Health Service has over 30 officers enrolled in preparation for future work assignments. During Fiscal Year 1960, 24 officers were enrolled. It is estimated that between 30 and 50 additional officers per year will be trained during the next two years.

In the Division's Training Grants Program, funds are made available to universities and other institutions to strengthen their programs for training radiation health specialists through improvement and enrichment of existing curricula and development and establishment of new study courses. Initiated in response to estimates of critical shortages of qualified personnel, as presented by the National Advisory Committee on Radiation, this program has received an allocation of $500,000 for Fiscal 1961. Grants are awarded upon approval by a NACOR training subcommittee. Applying institutions are required to state their current and planned activities in radiological health and the amount of funds needed. Continued expansion of the Training Grants Program is expected.

University Liaison Services are a continuing responsibility maintained by the Division of Radiological Health to assist educational institutions to plan curricula and to solve related problems. Typical of such Divisional activity was the August 1960 symposium, "University Curricula in Radiological Health," which it sponsored at Princeton, New Jersey. Over 100 representatives of interested institutions attended the meeting to discuss courses of study, personnel and equipment requirements, and other relevant needs in terms of training objectives. The interest generated by the many participants and attendees at meetings of this kind is expected to help assure adequate attention to the scope of radiological health in future curriculum planning.

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The United States Atomic Energy Commission provides data on the environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis.

The November and December 1960 issues of Radiological Health Data summarized the 1959 and the first quarter 1960 reports for fifteen installations. Second quarter 1960 reports for four of these installations appeared in the January 1961 issue. This month, four additional second quarter reports are summarized in the following sections.

AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

General Electric Company
Cincinnati, Ohio

August 1960

Environmental levels of radioactivity at the Aircraft Nuclear Propulsion Department (ANPD) for 1959 and first quarter 1960 were reported in the November 1960 Radiological Health Data. The following report presents a summary of the data for the second quarter of 1960.

The Cincinnati facilities of the ANPD are located within the metropolitan area, approximately 11 miles north of the main business district. The buildings lie approximately on the centerline of a wide valley at an elevation of 560 feet above sea level. The east fork of the Mill Creek, which flows into the Ohio River, runs several hundred feet east of the buildings (see figures 1 and 2).

The data obtained by the off-site monitoring program for alpha and beta-gamma airborne radioactivity are presented in table 1. Since airborne radioactivity can arise from many sources, such as natural deposits in the earth, fallout from weapons tests and discharges from atomic plants, the results obtained from the stack effluent air monitoring program are also presented in table 2.

TABLE 1.—OFF-SITE AIRBORNE RADIOACTIVITY

(Average concentrations in $\mu\mu c/m^3$)

Period	Location	Number samples	Long-lived alpha	Number samples	Beta-gamma
Second quarter 1960	Upwind	117	0.048	78	0.45
	Downwind	270	.055	180	.59
April	Upwind	27	.049	18	.54
	Downwind	99	.068	66	.84
May	Upwind	36	.050	24	.55
	Downwind	81	.043	54	.65
June	Upwind	54	.046	36	.27
	Downwind	90	.054	60	.27

TABLE 2.—STACK EFFLUENT AIR MONITORING

Second Quarter 1960

(Average concentrations in $\mu\mu c/m^3$)

Exhaust stack	Number samples	Alpha	Number samples	Beta-gamma
Main	111	0.004	111	0.09
Secondary	258	0.0009	93	0.07

Comparison of average stack effluent air concentrations of alpha and beta-gamma radioactivity with the average downwind concentrations detected in the off-site monitoring program during similar periods of time indicates that ANPD contributed negligible amounts of radioactivity to the atmosphere of the environs. In fact, even without consideration of the dilution that takes place with the atmosphere at the point of release, the effluent concentrations were notably less than the environmental levels, both upwind and downwind.

An extensive fallout sampling program continued to be followed. Data obtained by this program were reported separately to the Atomic Energy Commission and the Technical Information Service Extension. Levels of fallout during this period were, on the whole, barely measurable.

All liquid wastes known to be contaminated with radioactive materials are shipped for disposal at the Oak Ridge National Laboratory. However, since ordinary laboratory waste water is disposed in the city sanitary sewers, such waste is retained until analyses give assurance that it can be safely discharged. Measurements of the concentrations of alpha emitters in water discharged during the second quarter of 1960 are presented in table 3.

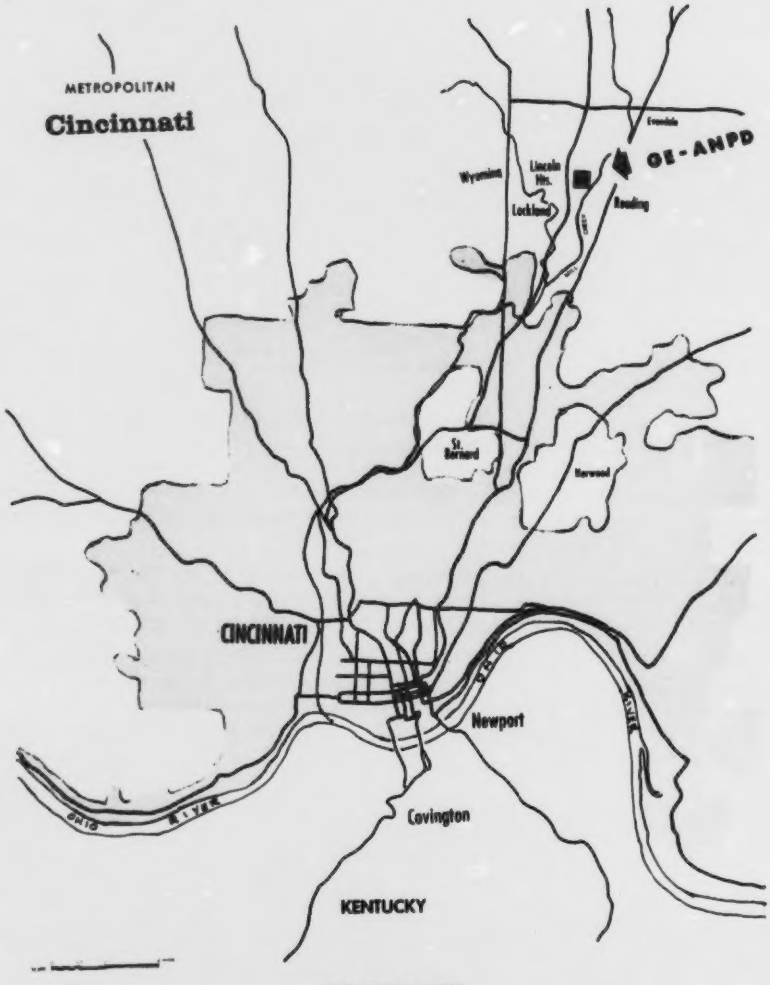
TABLE 3.--LIQUID WASTE FROM DRAIN SYSTEM

Second Quarter 1960

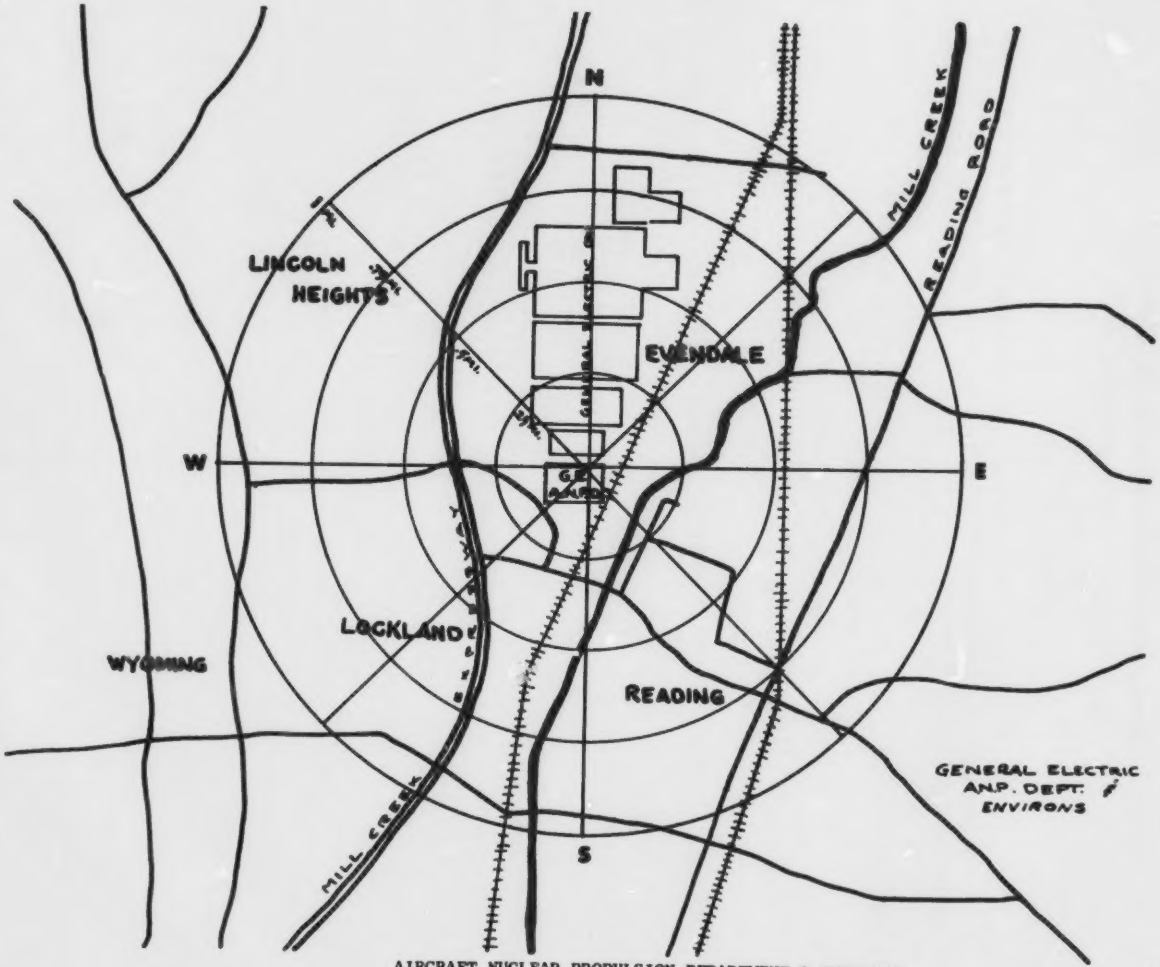
Period	Volume of liquid effluent (gallons)	Average concentration (μμc U/liter)
Second quarter 1960	896,500	3,000
April	275,500	4,400
May	300,500	2,100
June	320,500	2,500

The control level of 153,200 μμc U/liter in discharge water is based upon the radioactivity concentration guide level imposed by the city of Cincinnati and anticipated volumes of dilution water.

The data obtained in the environmental airborne and liquid effluent radioactivity monitoring programs during the second quarter of 1960 indicate that the operations at ANPD contributed an insignificant amount of radioactivity to the air and liquid wastes discharged to the city of Cincinnati sewerage system.


METROPOLITAN
Cincinnati
Evendale
GE-ANPD
Wyoming
Lincoln Hts.
Lockland
Reading
St. Bernard
Norwood
CINCINNATI
Newport
Covington
KENTUCKY
OHIO RIVER

LOCATION MAP
FIGURE 1


N
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LINCOLN HEIGHTS
EVENDALE
LOCKLAND
READING
WYOMING
MILL CREEK
READING ROAD
MILL CREEK
GENERAL ELECTRIC
G.E. ANPD
GENERAL ELECTRIC ANP. DEPT. & ENVIRONS

AIRCRAFT NUCLEAR PROPULSION DEPARTMENT & ENVIRONS

FIGURE 2

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113<

BROOKHAVEN NATIONAL LABORATORY

Associated Universities, Incorporated
Upton, New York

November 14, 1960

Environmental levels of radioactivity at the Brookhaven National Laboratory for 1959 and first quarter of 1960 were reported in the December 1960 Radiological Health Data. The following tables present the data for the second quarter of 1960.

TABLE 1.—AVERAGE RADIATION LEVELS AT BNL SITE BOUNDARY DUE TO LABORATORY OPERATIONS

Second Quarter—1960

(Average values in mr/week, from argon-41 in the reactor cooling air)

Period	N. Gate 680 m inside boundary	S. W. perimeter	S. E. perimeter	N. E. perimeter
Second quarter..............	0.70	0.18	0.40	0.75
April	0.35	0.20	0.37	0.98
May	1.17	0.12	0.49	0.64
June	0.57	0.20	0.36	0.65

The gross concentration and amount of radioactivity in the laboratory liquid waste effluent where it leaves the site is shown in table 2.

TABLE 2.—LIQUID WASTE EFFLUENT LEAVING THE BNL SITE

Second quarter—1960

Period	Volume of flow (gal/day)	Concentration of activity (μμc/liter)	Amount of activity (millicuries)
Whole quarter	817,000	96	26.4
April.............	906,000	68	7.0
May	815,000	93	8.9
June	731,000	127	10.5

CONNECTICUT AIRCRAFT NUCLEAR ENGINE

Pratt & Whitney Aircraft
Division of United Aircraft Corporation
Middletown, Connecticut

August 1, 1960

Environmental levels of radioactivity at Connecticut Aircraft Nuclear Engine Laboratory (CANEL) were reported in the November 1960 Radiological Health Data. The following report presents a summary of the data for the second quarter of 1960.

The environmental monitoring program at CANEL consists of collection and analysis of water, drinking water, Connecticut River water, process water, domestic sewer water, precipitation and air samples and measurement of external radiation levels.

Figure 1 shows a diagram of the sampling area around CANEL with the center near the center of the CANEL site. The outer circle is at a distance of five miles from the center of the site.

Water samples were collected once a month in each sector of an annulus from 3.1 through 7.4, as shown in figure 1. Sixty samples were collected in this quarter. The results are given in table 1.

TABLE 1.—ENVIRONMENTAL WATER

Second quarter—1960

Activity	Average concentration (μμc/liter)
Soluble alpha	0.30
Soluble beta............	3.94
Insoluble alpha........	1.31
Insoluble beta	6.09

Drinking water samples were collected from two wells in use at the CANEL site. Samples were collected once every 20 days. The well sampled at a given date was the one in use at that time. Three samples were taken in the second quarter.

TABLE 2.—DRINKING WATER—TWO WELLS

Second quarter 1960

Activity	Average concentration (μμc/liter)
Soluble alpha	0.25
Soluble beta............	0.34
Insoluble alpha........	0.55
Insoluble beta	5.07

Water samples were collected once a month from two separate locations along the Connecticut River. One location is near the north edge of the CANEL site and the other is near the south edge of the site. Three samples were taken at each location during the second quarter of 1960. Results were as follows:

TABLE 3.—CONNECTICUT RIVER WATER

Second quarter 1960

Location	Activity	Average concentration (μμc/liter)
North boundary of site.......	Soluble alpha	0.08
	Soluble beta	2.56
	Insoluble alpha	0.47
	Insoluble beta	5.51
South boundary of site.......	Soluble alpha	0.16
	Soluble beta	3.50
	Insoluble alpha	0.20
	Insoluble beta	2.95

Precipitation samples are collected as they occur at a central location on site, the Weather Station. A total of 31 samples was collected in the second quarter of 1960. Results were as follows:

TABLE 4.—PRECIPITATION

Second quarter 1960

Activity	Average concentration (μμc/liter)
Soluble alpha..........	1.46
Soluble beta............	56.4
Insoluble alpha........	0.69
Insoluble beta	17.6

Air samples were collected daily, except for week-ends and holidays, when weather permitted. These samples were collected at the weather station as well as at various locations on and around the CANEL site. The results are given in table 5.

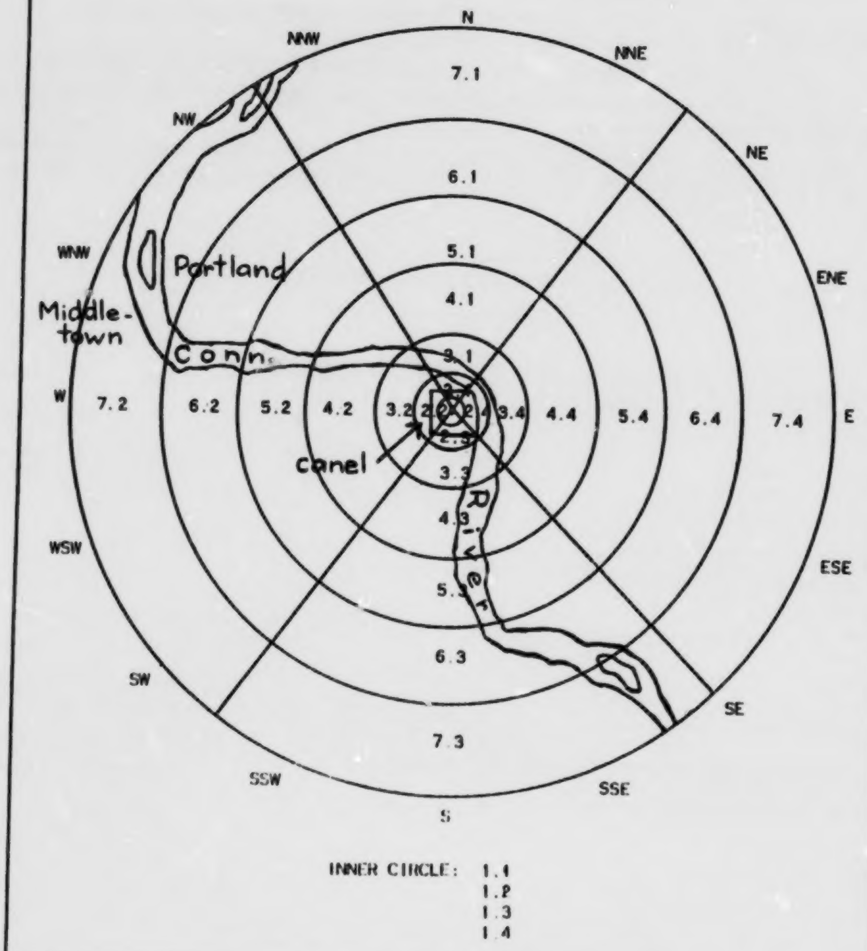
TABLE 5.—AIR SAMPLES

Second quarter 1960

Location	Activity	No. samples	Average concentration ($\mu\mu c/m^3$)
Weather station................	Alpha	40	0.0015
	Beta	40	0.06
On and around site............	Alpha	19	0.0032
	Beta	19	0.30

The data from the environmental monitoring show that the radioactivity in the environment is not greatly different from those levels found in previous years.

SAMPLING LOCALES—CONNECTICUT AIRCRAFT NUCLEAR ENGINE LABORATORY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SSW
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W
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NW
NNW
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5.1
4.1
3.1
7.2
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5.2
4.2
3.2
3.4
4.4
5.4
6.4
7.4
3.3
4.3
5.3
6.3
7.3
Portland
Middle-
town
Conn.
River
canel
INNER CIRCLE: 1.1
1.2
1.3
1.4

FIGURE 1

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NATIONAL REACTOR TESTING STATION

Health and Safety Division
Atomic Energy Commission
Idaho Falls, Idaho

Issued December 2, 1960

Environmental levels of radioactivity at the National Reactor Testing Station (NRTS) for 1959 and first quarter 1960 were reported in the December 1960 issue of Radiological Health Data. The following report presents the data for the second quarter of 1960.

The Health and Safety Division collects and analyzes a large number of water, air, milk and rabbit bone samples as part of their constant monitoring program (see figure 1 for sampling locations). The accompanying table presents the data.

The environmental monitoring data discloses that release of radioactive materials from NRTS operations during the second quarter was well below guide values recently adopted by the Federal Radiation Council.

TABLE 1.--ENVIRONMENTAL MONITORING DATA

Second Quarter 1960

Sample	Number stations	Approximate frequency	Number stations	Alpha	Beta
Off-site ground water..........	29	Bimonthly	34	<3 μμc/liter	<150 μμc/liter
On-site production well water	22	Weekly	209	<3 μμc/liter	<150 μμc/liter
Off-site air	10	Weekly	124	-	1 μμc/m^3
Perimeter ... . rabbit bones* (jack rabbit)	10	Quarterly	15	17 μμc Sr^{90}/gm Ca	
Off-site control.................. rabbit bones (jack rabbit)*	10	Quarterly	19	21 μμc Sr^{90}/gm Ca	
Off-site milk	30	Monthly	60	<1000 μμc I^{131}/liter	
Off-site monitoring badges...	118	Monthly	354	β < 20 mrem/90 days γ < 20 mrem/90 days	

*Analysis for Sr^{90} in jack rabbit bones is for first quarter 1960.

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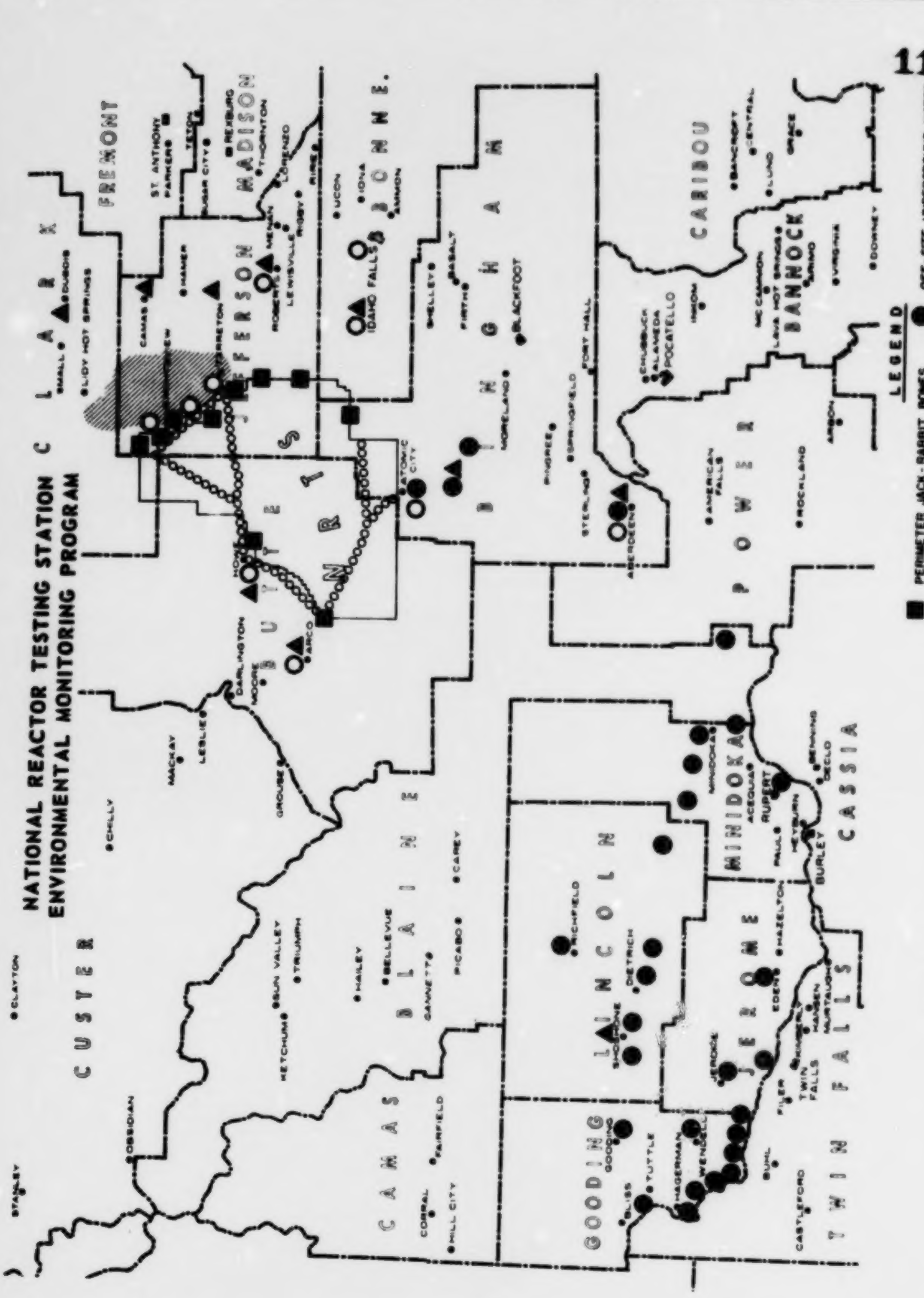
NATIONAL REACTOR TESTING STATION
ENVIRONMENTAL MONITORING PROGRAM


CUSTER
CLARK
FREMONT
MADISON
JEFFERSON
BONNEVILLE
BINGHAM
CARIBOU
BANNOCK
POWER
BUTTE
BLAINE
CAMAS
GOODING
LINCOLN
JEROME
MINIDOKA
CASSIA
TWIN FALLS
STANLEY
CLAYTON
OBSIDIAN
CHILLY
MACKAY
LESLIE
GROUSE
DARLINGTON
MOORE
ARCO
HOWE
ATOMIC CITY
SMALL
DUBOIS
LIDY HOT SPRINGS
CAMAS
MUD LAKE
TERRETON
HAMER
ST. ANTHONY
PARKER
TETON
SUGAR CITY
REXBURG
THORNTON
LORENZO
MENAN
ROBERTS
LEWISVILLE
RIGBY
RIRIE
UCON
IONA
AMMON
IDAHO FALLS
SHELLEY
BASALT
FIRTH
BLACKFOOT
MORELAND
PINGREE
SPRINGFIELD
STERLING
ABERDEEN
FORT HALL
CHUBBUCK
ALAMEDA
POCATELLO
INKOM
McCAMMON
LAVA HOT SPRINGS
ARIMO
VIRGINIA
DOWNEY
BANCROFT
CENTRAL
LUND
GRACE
AMERICAN FALLS
ROCKLAND
ARBON
KETCHUM
SUN VALLEY
TRIUMPH
HAILEY
BELLEVUE
GANNETT
PICABO
CAREY
FAIRFIELD
CORRAL
HILL CITY
RICHFIELD
DIETRICH
SHOSHONE
GOODING
TUTTLE
BLISS
HAGERMAN
WENDELL
JEROME
EDEN
HAZELTON
BUHL
FILER
TWIN FALLS
KIMBERLY
HANSEN
MURTAUGH
CASTLEFORD
ACEQUIA
RUPERT
MINIDOKA
PAUL
HEYBURN
BURLEY
DECLO
EMBLING

LEGEND

- ■ PERIMETER JACK-RABBIT BONES
- ▲ OFF-SITE JACK-RABBIT BONES
- ▨ MILK SAMPLING AREA
- ● OFF-SITE UNDERGROUND WATER
- ○ OFF-SITE AIR FILTERS
- ooo AREA MONITORING BADGES

FIGURE 1

RADIOLOGICAL HEALTH DATA

MONTHLY REPORT

MARCH 1961

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Radiological Health

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PREFACE

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

Radiological Health Data is published by the Public Health Service on a monthly basis. Data are provided to the Division of Radiological Health by other Federal agencies, State health departments, and by foreign governments. Except where material is directly quoted, summaries are prepared by the staff of the Division of Radiological Health. The reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
Atomic Energy Commission
Department of Defense
Department of Commerce
Department of Agriculture

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SECTION I.—AIR

PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in environmental radiation due to radioactive fallout from nuclear weapons tests. Although no nuclear tests have been conducted by the United States since 1958, the program has proved sufficiently valuable that it has been extended to a round-the-year basis and currently consists of 45 stations at urban locations (see figure 1) operated by State and local health department personnel with 2 stations operated by U. S. Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment, and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. However, field measurements do enable the operator to estimate the amount of beta activity of particulates in the air at the station five hours after collection by comparison with a known source, using a portable survey meter. The filters are then forwarded to a laboratory in Washington, D. C. for a more refined measurement using a thin window proportional counter.

Air samplers are in operation at the 45 stations on an average of 70 percent of the week. Air is drawn through a cellulose carbon loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small dust-like particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples.

About 85 percent of the stations collect samples of precipitation which are sent to Washington, D. C. for analysis. Values are now below limits of detection by present instrumentation. New equipment is being procured to measure lower values. Measurements have indicated that the bulk of deposited activity occurs through precipitation, but concentrations in surface air are not directly related to the amount deposited through precipitation.

Tables 1 and 2 summarize the data for October 1960.

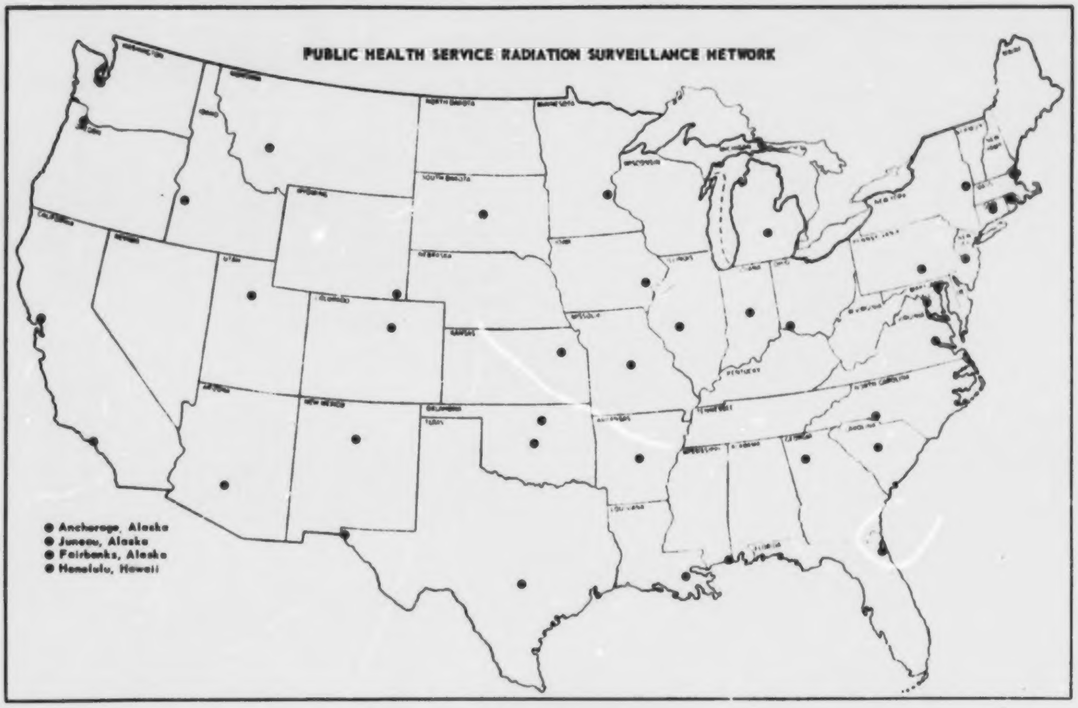

FIGURE 1

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TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR-GROSS BETA DETERMINATION

Public Health Service Radiation Surveillance Network

October 1960

Station Location	Weighted average (μμc/m³)	Maximum (μμc/m³)	Minimum (μμc/m³)
Alaska, Anchorage	< 0.10	< 0.10	< 0.10
Alaska, Fairbanks	< 0.10	0.12	< 0.10
Alaska, Juneau	< 0.10	< 0.10	< 0.10
Arizona, Phoenix	< 0.10	0.12	< 0.10
Arkansas, Little Rock	< 0.10	0.12	< 0.10
California, Berkeley	< 0.10	< 0.10	< 0.10
California, Los Angeles	< 0.10	0.11	< 0.10
Colorado, Denver	< 0.10	< 0.10	< 0.10
Connecticut, Hartford	< 0.10	0.13	< 0.10
District of Columbia	< 0.11	< 0.20	< 0.10
Florida, Jacksonville	< 0.10	< 0.10	< 0.10
Georgia, Atlanta	< 0.10	0.12	< 0.10
Hawaii, Honolulu	< 0.10	< 0.10	< 0.10
Idaho, Boise	< 0.10	< 0.10	< 0.10
Illinois, Springfield	< 0.11	0.17	< 0.10
Indiana, Indianapolis	< 0.10	0.13	< 0.10
Iowa, Iowa City	< 0.10	0.12	< 0.10
Kansas, Topeka	< 0.10	< 0.10	< 0.10
Louisiana, New Orleans	< 0.10	< 0.10	< 0.10
Maryland, Baltimore	< 0.10	0.10	< 0.10
Massachusetts, Lawrence	< 0.10	< 0.10	< 0.10
Michigan, Lansing	< 0.10	0.16	< 0.10
Minnesota, Minneapolis	< 0.10	< 0.10	< 0.10
Mississippi, Pascagoula	< 0.13	0.18	< 0.10
Missouri, Jefferson City	< 0.10	< 0.10	< 0.10
Montana, Helena	< 0.10	< 0.10	< 0.10
New Jersey, Trenton	NO SAMPLES RECEIVED		
New Mexico, Santa Fe	< 0.12	0.19	< 0.10
New York, Albany	< 0.10	0.13	< 0.10
North Carolina, Gastonia	< 0.11	0.18	< 0.10
Ohio, Cincinnati	0.1	0.2	0.0
Oklahoma, Oklahoma City	< 0.10	< 0.10	< 0.10
Oklahoma, Ponca City	< 0.10	< 0.10	< 0.10
Oregon, Portland	< 0.10	0.14	< 0.10
Pennsylvania, Harrisburg	< 0.10	0.16	< 0.10
Rhode Island, Providence	< 0.10	< 0.10	< 0.10
South Carolina, Columbia	< 0.10	< 0.10	< 0.10
South Dakota, Edgemont	INACTIVATED		
South Dakota, Pierre	< 0.10	0.12	< 0.10
Texas, Austin	< 0.10	< 0.10	< 0.10
Texas, El Paso	< 0.13	0.22	< 0.10
Utah, Salt Lake City	< 0.19	2.06	< 0.10
Virginia, Richmond	< 0.10	0.11	< 0.10
Washington, Seattle	< 0.10	< 0.10	< 0.10
Wyoming, Cheyenne	< 0.10	< 0.10	< 0.10

TABLE 2.--RADON AND THORON MEASUREMENTS

Public Health Service Radiation Surveillance Network
Station at Cincinnati, Ohio

October 1960

Date	Continuous sample collection			Radon[(a)] a.m. ($\mu\mu c/m^3$)	Radon[(b)] p.m. ($\mu\mu c/m^3$)	Thoron[(c)] ($\mu\mu c/m^3$)	Beta[(d)] activity ($\mu\mu c/m^3$)
	Sample change time	Sampling period (hours)	Volume (m^3)				
3	0812	71.8	87.5	670	260	8.3	0.1
4	0835	24.3	27.5	780	210	9.6	0.1
5	0800	23.4	26.9	1300	270	3.9	0.2
6	0820	24.3	29.5	220	330	3.2	0.1
7	0805	23.8	28.9	450	190	4.0	0.1
10	0825	72.3	85.0	940	220	6.9	0.1
11	0816	23.8	28.5	790	250	7.7	0.2
12	0815	24.0	29.3	1000	290	9.1	0.2
13	0810	23.9	29.1	1200	260	9.9	0.1
14	0810	24.0	29.1	1500	260	10.7	0.2
17	0810	72.0	82.1	610	150	8.0	0.1
18	0818	24.0	29.5	920	430	8.5	0.1
19	0815	23.9	29.1	740	640	8.5	0.2
20	0816	24.0	29.1	160	90	2.4	0.1
21	0820	24.0	29.4	930	130	4.6	0.2
24	0943	73.3	90.2	160	90	2.9	0.1
25	0825	22.7	28.2	980	150	6.8	0.1
26	0825	24.0	29.4	470	310	7.1	0.1
27	0820	23.9	29.4	410	520	3.5	0.0
28	0820	24.0	29.2	570	310	3.5	0.1
31	0805	71.7	86.5	220	160	3.4	0.1
Average...............................				650	240	6.0	0.12

(a) Radon concentrations are derived from alpha measurements determined immediately after the sampling period (24-96 hours) has ceased. Reported radon concentrations have been corrected for any thoron daughter interferences. Twice the standard deviation (2 σ) falls between ± 20 and ± 70 $\mu\mu c/m^3$.

(b) Radon concentrations are derived from alpha measurements made in the afternoon approximately 7 hours (3 p.m.) after the raw sampling period has begun. Reported radon concentrations are uncorrected for any thoron daughter interferences. Twice the standard deviation (2 σ) falls between ± 16.0 and ± 45.0 $\mu\mu c/m^3$.

(c) Thoron concentrations are derived from alpha measurements made from the same filters used in footnote a, above, but are counted approximately 7 hours after the sampling period has ceased. Twice the standard deviation (2 σ) falls between ± 0.30 and 0.70 $\mu\mu c/m^3$.

(d) Gross beta concentrations are based on measurements made at least 4 days after each sampling period (24-96 hours) has ceased. Twice the standard deviation (2 σ) falls between ± 0.01 and ± 0.03 $\mu\mu c/m^3$.

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RADIOACTIVITY MEASUREMENTS IN AIR

U. S. Naval Research Laboratory

Radioactivity measurements of air-filter samples collected at various sites along the 80th Meridian (West) are made by the U. S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during October 1960 is shown in table 1, while the radioactivity profile for the same month is shown in figure 1. All radioactivity concentrations are given in disintegrations per minute per cubic meter of air at the collecting site (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

TABLE 1.--DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION

U. S. Naval Research Laboratory

October 1960

(dpm/m^3)

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofa-gasta, Chile	Chacal-taya, Bolivia	Lima, Peru	Guaya-quil, Ecuador
1	-	0.03	0.09	0.11	0.02	0.06	0.02
2	-	0.03	0.09	0.11	0.02	0.06	0.02
3	-	0.03	0.09	0.11	0.02	0.06	0.02
4	-	0.06	0.07	0.08	0.03	0.04	0.02
5	-	0.06	0.07	0.08	0.03	0.04	0.02
6	-	0.04	0.04	0.17	0.05	0.04	0.02
7	-	0.04	0.04	0.17	0.05	0.04	0.02
8	-	0.04	0.07	0.13	-	0.10	0.04
9	-	0.04	0.07	0.13	0.03	0.10	0.04
10	-	0.04	0.07	0.12	0.03	0.10	0.05
11	-	0.01	0.08	0.12	0.03	0.09	0.05
12	-	0.01	0.08	0.12	0.05	0.09	0.06
13	-	0.04	0.11	0.14	0.06	0.11	0.04
14	-	0.04	0.11	0.14	0.08	0.11	0.03
15	-	0.04	-	0.17	0.11	0.05	0.03
16	-	0.04	0.11	0.17	0.12	0.05	0.03
17	-	0.04	0.11	0.17	0.12	0.05	0.04
18	-	0.04	0.09	-	0.08	0.11	0.02
19	-	0.04	0.09	-	0.08	0.11	0.02
20	-	0.04	0.09	-	0.05	0.03	0.02
21	-	0.04	0.09	-	0.05	0.03	0.02
22	-	0.03	0.06	-	0.05	0.04	0.02
23	-	0.03	0.06	-	0.05	0.04	0.02
24	-	0.03	0.06	-	0.09	0.04	0.02
25	-	0.03	0.09	-	0.08	0.05	0.05
26	-	0.03	0.09	-	0.11	0.05	0.06
27	-	0.08	0.14	-	0.08	0.05	0.03
28	-	0.08	0.14	-	0.05	0.05	0.03
29	-	0.08	0.14	-	0.06	0.06	0.03
30	-	0.08	0.14	-	0.06	0.06	0.03
31	-	0.08	0.14	-	0.12	0.06	0.05
Mean value	-	0.04	0.09	0.13	0.06	0.06	0.03

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TABLE 1.--DAILY RECORD OF FISSION PRODUCT BETA ACTIVITY COLLECTED BY AIR FILTRATION--Con.

U. S. Naval Research Laboratory

October 1960

(dpm/m^3)

Day	Miraflores, Panama Canal	Mauna Loa, Hawaii	Miami, Florida	Washington, D. C.	Moosonee, Ontario, Canada	Thule, Greenland	Bravo, Arctic Ice Floe
1	0.04	0.06	0.06	0.12	0.07	0.03	0.02
2	0.04	0.06	0.06	0.12	0.07	0.03	0.02
3	0.04	0.06	0.06	0.12	0.07	0.03	0.02
4	0.03	0.11	0.10	0.10	0.09	0.04	0.04
5	0.03	0.11	0.10	0.10	0.09	0.04	0.04
6	0.03	0.11	0.07	0.16	0.08	0.08	0.04
7	0.03	0.11	0.07	0.16	0.08	0.08	0.04
8	0.03	0.15	0.04	0.11	0.03	0.05	0.04
9	0.03	0.15	0.04	0.11	0.03	0.05	0.04
10	0.03	0.15	0.04	0.11	0.03	0.05	0.05
11	0.02	0.06	0.04	0.20	-	0.06	0.05
12	0.02	0.06	0.04	0.20	-	0.06	0.05
13	0.03	0.07	0.04	0.32	0.08	0.05	0.05
14	0.03	0.07	0.04	0.32	0.08	0.05	0.05
15	0.02	0.07	0.05	0.21	0.10	0.07	0.05
16	0.02	0.07	0.05	0.21	0.10	0.07	0.05
17	0.02	0.07	0.05	0.21	0.10	0.07	0.05
18	0.03	0.02	0.11	0.29	0.03	0.04	0.05
19	0.03	0.02	0.11	0.29	0.03	0.04	0.05
20	0.02	0.02	0.08	0.16	0.10	0.10	0.05
21	0.02	0.02	0.08	0.16	0.10	0.10	0.05
22	0.02	0.03	0.14	0.15	0.10	0.04	0.05
23	0.02	0.03	0.14	0.15	0.10	0.04	0.07
24	0.02	0.03	0.14	0.15	0.10	0.04	0.07
25	0.02	0.08	0.17	0.13	0.10	0.02	0.07
26	0.02	0.08	0.17	0.13	0.10	0.02	0.07
27	0.02	0.04	0.08	0.16	0.20	0.07	0.07
28	0.02	0.04	0.08	0.16	0.20	0.07	0.07
29	0.02	0.09	0.17	0.16	0.12	0.03	0.07
30	0.02	0.09	0.17	0.16	0.12	0.03	0.07
31	0.02	0.09	0.17	0.16	0.12	0.03	0.07
Mean value	0.03	0.07	0.09	0.17	0.09	0.05	0.05

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PROFILE OF BETA ACTIVITY

AVERAGE MEASUREMENTS OF SURFACE AIR AT STATIONS ALONG THE 80TH MERIDIAN (WEST)

U. S. Naval Research Laboratory

October 1960

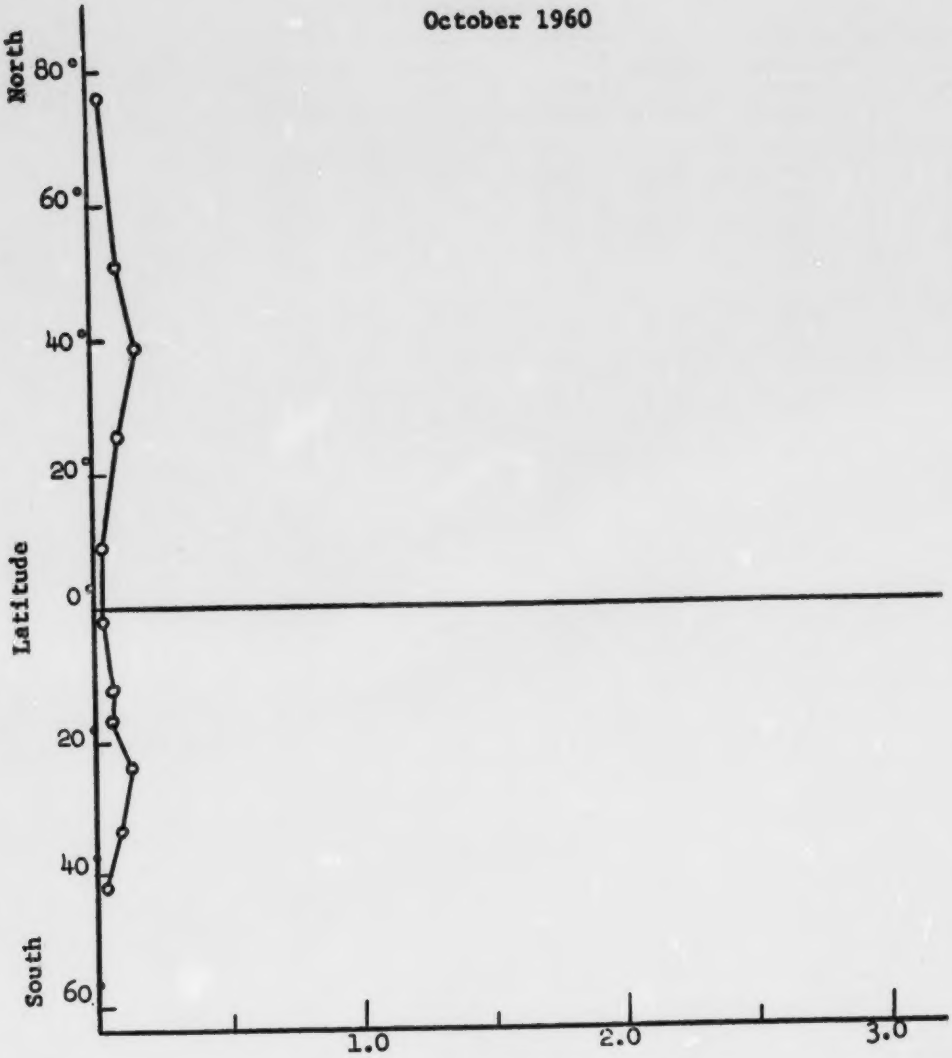

FIGURE 1. AVERAGE FISSION PRODUCT BETA ACTIVITY (dpm/m³)

SECTION II.—FOOD, OTHER THAN MILK

HIGH CONSUMPTION OF FOODS

United States Department of Agriculture
Agricultural Research Service
Household Economics Research Division

Because of an increasing need for estimating chemical residues, food additives and radioactivity in foods, there has been growing interest in information on quantities of foods used by high consumers as well as average consumers. Tables showing average quantities of some 200 foods used per person per household were prepared by the United States Department of Agriculture based on its 1955 Household Food Consumption Survey. These were published in Radiological Health Data, Volume I, Numbers 5, 6 and 7.

The 1955 survey (latest nationwide) has also been used to estimate quantities of some 60 foods used by high consumers. Although the survey does not provide information on consumption by individuals (only on quantities used by the household group), statistical measures have been computed that are a useful, though not exact, measure of what high consumers of each designated product consumed in one week during the spring of 1955. Any calculation of quantities of foods used by high consumers obviously involves a decision as to what is "high." The ninth decile has been adopted since it is reasonably simple to compute and is not likely to be influenced by a few unusually high reports as might be the case with the "the highest one" or the "mean of the highest 10 percent." A "ninth decile" is a value that divides the highest 10 percent of consumers from the other 90 percent. They were computed from special tabulations: listings, in order of magnitude, of a week's consumption per person in each household. Before the listings could be made, the quantity reported to have been used at home during the previous 7 days by each housekeeping household was divided by the size of that household (in 21 meal-at-home equivalent persons).

Amounts of foods used by high consumers as reported here are not additive. Persons eating large quantities of one item do not necessarily eat large quantities of other items. No household or individual within a household could possibly consume all of the foods in the amounts listed as high consumption.

Because it may be useful to compare the consumption means and these newly derived estimates of quantities consumed by high consumers, the tables present the two statistics for each region. The estimated ninth decile is from 1 1/2 to 3 1/2 times the mean for broad groups of foods. In general the ratios for the items within the groups are even higher than the ratios for the groups, for the more finely specified the food (i.e., an item rather than a group) the greater the family-to-family variability and, therefore, the greater the magnitude of the measure of the variability used (such as the ratio here).

Limitations of data

As estimates of high consumption by individuals, these ninth decile values tend to be low. This is because the data for high-consuming individuals have been combined with that of other members of the same household to obtain per-person averages.

Another limitation of the method results from the fact that the basic data are for a week. Considerable week-to-week variability in household food consumption is believed to exist. This tends to make the ninth decile a poorer estimate of sustained medium high consumption than of short-term, very high consumption.

In addition to the problems of definition inherent in using the "average consumption per person" for each household, the method of computing the ninth decile value from the arrays also tends to underestimage this "high consumption value." Theoretically, the ninth decile should be computed from an array or distribution of the values for all households arranged in order of magnitude. These consumption values, however, were arrayed within income class and within urbanization group for each region. An approximation of the ninth decile was made by computing first the ninth decile for each of the subclasses, and then the weighted mean of these ninth deciles. The approximations were compared with the exactly computed ninth deciles for a sample of the results. Almost without exception, the approximations were quite close but somewhat low.

The comparison of the ninth decile with the mean is not technically appropriate on two grounds: (a) the ninth decile is the value at a point in the array, so it should be compared with the medium rather than the mean, and (b) the deciles and means were computed with basically different weights. In the former, equal weight was given to each household; in the latter, equal weight to each person. Per person consumption tends to be less in larger households, hence the mean is smaller than if equal weight were given to each household. Since these two factors have counteracting effects their net result on the ratios of high to average consumption is probably not great.

Table 1 shows high consumption defined as the ninth decile and average consumption as the mean value.

TABLE 1.—HIGH AND AVERAGE FOOD CONSUMPTION PER PERSON PER WEEK IN HOUSEHOLDS BY REGION, SPRING 1955

(Pounds)

Food	Northeast		North Central		West		South	
	High[1]	Average[2]	High[1]	Average[2]	High[1]	Average[2]	High[1]	Average[2]
Milk, cream, ice cream, cheese (fluid milk equivalent[3])	15.59	9.72	15.81	10.24	16.73	10.42	16.25	8.56
Fresh fluid milk, total	12.35	7.37	13.22	8.05	13.29	7.54	13.39	6.00
Whole	12.00	7.00	.2.60	7.52	12.27	6.80	11.44	4.94
Processed milk	1.98	.25	1.70	.19	2.93	.41	3.63	.51
Cream	.36	.10	.40	.12	.32	.10	.10	.03
Ice cream, ice milk	.83	.34	1.17	.47	1.07	.41	.91	.29
Cheese	.77	.33	.90	.38	.98	.43	.56	.21
Fats and oils, total	1.24	.76	1.51	.88	1.52	.92	1.73	1.01
Table fats, total	.69	.43	.79	.44	.79	.43	.66	.32
Butter	.58	.24	.60	.25	.50	.18	.41	.13
Margarine	.40	.19	.50	.19	.55	.25	.47	.19
Shortening	.34	.13	.54	.24	.45	.22	.94	.46
Salad and cooking oils	.23	.08	.12	.04	.27	.09	.12	.05
Salad dressings (commercial)	.31	.12	.37	.16	.41	.18	.39	.17
Flour and other cereal products, total	1.96	1.03	2.63	1.40	2.55	1.48	4.84	2.82
Flour other than mixes	.84	.32	1.46	.62	1.40	.66	2.63	1.42
Prepared flour mixes	.54	.17	.64	.22	.71	.26	.36	.13
Breakfast cereals (excluding baby cereals)	.51	.25	.56	.28	.58	.28	.48	.19
Other cereals	.69	.29	.60	.27	.64	.28	2.16	1.08
Bakery products, total	3.70	2.22	3.77	2.25	3.72	2.14	3.20	1.59
Bread	2.58	1.53	2.79	1.62	2.79	1.55	2.29	1.09
Baked goods other than bread	1.54	.69	1.39	.63	1.41	.59	1.26	.50
Eggs	1.39	.78	1.57	.87	1.70	.96	1.65	.84
Meat, poultry, fish, total	7.38	4.33	7.42	4.37	7.58	4.34	6.98	3.70
Meat, total	5.46	3.07	5.70	3.38	5.93	3.37	4.80	2.58
Beef	2.66	1.29	2.98	1.51	3.46	1.62	2.04	.85
Veal	.43	.12	.40	.07	.28	.07	--	.04
Pork	2.29	.98	2.63	1.23	2.24	1.00	2.69	1.26
Lamb, mutton	.59	.19	--	.05	--	.13	--	.02
Variety meats and game	.31	.13	.34	.10	.52	.17	.34	.10
Luncheon meats	.78	.37	.91	.42	.83	.37	.73	.30
Poultry, total	2.16	.83	1.78	.65	1.83	.61	1.80	.70
Chicken[4]	1.99	.69	1.68	.59	1.72	.55	1.78	.67
Fish and shellfish	.99	.44	.72	.34	.87	.37	1.21	.42

See footnotes at end of table.

TABLE 1.--HIGH AND AVERAGE FOOD CONSUMPTION PER PERSON PER WEEK IN HOUSEHOLDS BY REGION, SPRING 1955--Con.

(Pounds)

Food	Northeast		North Central		West		South	
	High[1]	Average[2]	High[1]	Average[2]	High[1]	Average[2]	High[1]	Average[2]
Sugar, sweets, total	1.84	.99	2.30	1.28	2.22	1.20	3.34	1.45
Sugar	1.35	.67	1.65	.86	1.55	.75	1.83	.95
Sirups, molasses, honey	.23	.07	.27	.09	.33	.13	.55	.22
Jellies, jams	.33	.13	.46	.19	.43	.18	.53	.21
Candies (commercial)	.38	.12	.38	.13	.36	.13	.26	.08
Potatoes, sweetpotatoes, total	3.59	1.96	3.79	2.19	3.18	1.70	3.12	1.56
Fresh	3.48	1.90	3.72	2.09	3.11	1.62	3.08	1.53
Potato chips and sticks	.12	.03	.49	.06	.15	.04	.04	.02
Other	--	.02	--	.03	--	.04	--	.02
Fresh vegetables, total[5]	5.28	2.64	4.85	2.45	5.66	2.76	6.07	2.85
Dark green and deep yellow	1.25	.51	.91	.37	1.09	.43	1.16	.40
Other green	1.97	.94	2.21	.99	2.66	1.03	2.66	1.19
Tomatoes	.81	.34	.87	.32	.93	.35	1.06	.40
Other than tomatoes, and green and deep yellow	1.93	.85	1.75	.76	2.07	.94	2.11	.86
Fresh fruits, total[5]	6.32	2.93	6.72	3.26	6.84	3.18	5.47	2.33
Citrus	3.27	1.24	3.35	1.34	3.57	1.30	2.92	.91
Other than citrus	3.90	1.69	4.01	1.92	3.86	1.88	3.38	1.42
Commercially frozen fruits and vegetables, total	.67	.22	.55	.17	.76	.21	.37	.11
Fruits[6]	.13	.03	.11	.04	--	.03	--	.02
Vegetables other than potatoes	.63	.19	.41	.13	.02	.19	.31	.09
Commercially canned fruits and vegetables, total	2.62	1.23	2.91	1.39	3.11	1.48	2.56	1.00
Fruits, except baby and junior foods	1.22	.42	1.24	.48	1.52	.54	.98	.30
Vegetables, except baby and junior foods	1.64	.73	1.88	.85	2.08	.86	1.77	.64
Baby and junior foods	--	.08	--	.06	--	.08	--	.05
Fruit and vegetable juices, fresh, frozen, canned, powdered[7]	3.23	1.31	3.00	1.20	3.01	1.15	2.00	.67
Canned citrus[7]	1.05	.28	1.13	.32	.84	.27	.71	.24
Canned fruit other than citrus[7]	.99	.27	.48	.15	.70	.20	.29	.11
Canned tomato and other vegetable[7, 8]	.80	.20	.84	.23	.85	.21	.35	.11
Frozen concentrated	.50	.14	.51	.13	.40	.13	.12	.05
Fresh (commercial)	--	.05	--	.04	--	.01	--	.03
Dried fruits and vegetables, total[8]	.37	.11	.36	.12	.58	.21	.73	.30
Dried fruit	.21	.05	.20	.05	.28	.07	.14	.05
Dry vegetables	.14	.05	.21	.07	.33	.13	.61	.25
Beverages:								
Coffee	0.54	0.23	0.56	0.27	0.74	0.30	0.49	0.20
Tea[9]	.11	.03	.08	.02	.06	.02	.12	.03
Chocolate, cocoa, chocolate sirup	.08	.03	.08	.03	.06	.02	.06	.02
Soft drinks, fruit ades	2.76	.93	2.56	.96	2.19	.70	2.54	.90

See footnotes at end of table.

TABLE 1.–HIGH AND AVERAGE FOOD CONSUMPTION PER PERSON PER WEEK IN HOUSEHOLDS BY REGION, SPRING 1955–Con.

(Pounds)

Food	Northeast		North Central		West		South	
	High[1]	Average[2]	High[1]	Average[2]	High[1]	Average[2]	High[1]	Average[2]
Miscellaneous foods:								
Nuts (shelled weight) and peanut butter	.26	.09	.24	.09	.26	.10	.21	.07
Soups, except canned baby soups	.68	.24	.67	.25	.84	.34	.34	.11
Catsup, chili sauce, etc.	.32	.12	.31	.12	.37	.16	.19	.06
Pickles, olives, relishes[8]	.35	.12	.57	.20	.44	.15	.36	.12
Puddings, pie fillings, miscellaneous sweets (commercial)	.24	.09	.29	.10	.30	.11	.19	.06
Other mixtures, prepared or partially prepared	.70	.22	.55	.17	.77	.24	.45	.15
Leavening agents[9]	--	.02	.06	.03	.07	.03	.19	.05

[1] Ninth decile.

[2] Mean.

[3] Approximately the quantity of fluid milk to which the various dairy products (except butter) are equivalent in calcium. The products listed in the breakdown are shown as actual quantities.

[4] Chiefly fresh or frozen. Only small amounts of canned reported.

[5] Includes home canned and frozen items that were brought into the home in fresh form.

[6] Chiefly strawberries.

[7] Single strength equivalent; total includes the concentrated and dry items on the basis of single strength equivalent.

[8] Includes both commercially and home prepared products.

[9] Data refer to amounts bought during the 7-day period rather than the amounts used.

SECTION III.—MILK

PUBLIC HEALTH SERVICE MILK MONITORING PROGRAM

The original Public Health Service Milk Monitoring Program consisted of 12 sampling stations of which 9 are still active. Raw milk was spot sampled at these stations. During 1960 a new sampling program of about 60 stations was established. Processed milk was sampled at these stations. Since the sampling procedures for the raw milk sampling stations and the processed milk area sampling stations are different, they are described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations; the Public Health Service Southeastern Radiological Health Laboratory at Montgomery, Alabama, and the Southwestern Radiological Health Laboratory at Las Vegas, Nevada, provide this service for the new program.

The purpose of the two sampling programs is not the same. The original network was established to develop sampling and radiochemical analytical proficiencies. During the existence of this program it became apparent that a broader sampling program, more directly related to the milk consumed by the population, was necessary, and the Public Health Service and the Department of Health, Education, and Welfare moved to provide facilities for this change. This resulted in the transition from the program of sampling raw milk, collected from milksheds of limited size, to a sampling program designed to be representative of the processed milk consumed in a given municipality.

In some instances the designated points are the same as those which were reported originally. The establishment of the new processed milk area sampling stations does not preclude the need for further raw milk sampling from the selected milkshed serving the same city. It is important that both networks be in operation for a sufficient period of time to provide an overlap for the purpose of comparative study.

Because of the different sources of these samples, changes in the collecting system, and the utilization of different laboratory techniques, differences were anticipated in the amounts of radioactivity found in the milk under the two programs. For this reason, an investigation to determine the comparability of the two programs was begun in January 1961. This investigation covers all possible factors including both the laboratory methodology and collecting methods. Until this study has been completed and additional experience has been gained under the new program, no valid interpretation can be made of any differences of radioactivity in milk samples collected under the two systems.

Publication of the data will normally follow about four months after collection of samples because of the time required for shipment, processing, decay product build-up, compilation of the data, clearance and publication procedures.

RAW MILK SAMPLING STATIONS

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Public Health Service to determine trends in our changing environment, including measurement of amounts of radioactivity in water, air, milk and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop effective collection systems and radiochemical analysis procedures to make them more suitable for larger scale programs.

The criteria on which the selection of the original sampling stations was based appeared in the discussion sections of all Volume I issues of Radiological Health Data.

One-gallon raw milk samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center for radionuclide analysis. It is estimated that these samples represent 2,000-gallon lots. The concentrations of iodine-131, barium-140, cesium 137 and naturally occurring potassium-40 are all currently being measured, when present in the milk, by gamma scintillation spectroscopy. Total radiostrontium and strontium-90 are determined following radiochemical separations, the strontium-90 being calculated by measuring the build-up in a two-week period of the daughter decay product, yttrium-90, using a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter with the strontium-89 calculated as the difference.

April through September 1960 issues of Radiological Health Data list references for technical descriptions of the methodology of analyses used.

October data for the raw milk sampling stations are presented in table 1.

PROCESSED MILK AREA SAMPLING STATIONS

The monitoring of milk has been expanded to provide additional information on levels of radioactivity in milk consumed by the public. The new stations have been established in cooperation with State and local health and milk sanitation agencies. The cities have been selected in order to provide adequate coverage from the combined viewpoints of production areas and consuming population. The emphases on this expanded sampling and radioassay program are:

1. measuring the radioactivity levels of the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the processing plant, and
2. providing one sampling point within each State with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving the milk production and milkshed area characteristics.

The new network was designed to sample processed milk rather than the raw product. The sampling procedure was developed to provide a sample from one day's sales per month in a community which will be as representative of the total supply as can be achieved under practical conditions. The sample will be a composite of those plants supplying not less than 90% of the city's milk supply. The contribution from each plant to the total sample will be approximately proportional to volume of milk sold.

The samples from the new stations are collected with the assistance of the various State and local health and milk sanitation agencies and are shipped for analysis to either the Southwestern or Southeastern Radiological Health Laboratory. The Southeastern Radiological Health Laboratory processes samples from the 30 states generally east of the Mississippi, and the Southwestern Radiological Health Laboratory processes samples from the western states.

At the present time radioassays for Sr^{89}, Sr^{90} and Cs^{137} are being performed. Other radionuclides of concern to public health agencies will be included for assay as necessary for complete monitoring of the milk supply.

Data from the two laboratories are presented in table 2.

TABLE 1.--RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program
Robert A. Taft Sanitary Engineering Center

Raw Milk Sampling Stations

October 1960

(Radioactivity in $\mu\mu c$/liter)

Area	Calcium (grams/liter)		Iodine-131		Strontium-89		Strontium-90		Barium-140		Cesium-137	
	Oct.	Yearly average	Oct.	Yearly average	Oct.	Yearly average	Oct.	Yearly average	Oct.	Yearly average	Oct.	Yearly average
Atlanta, Ga.	1.11	1.12	ND	< 10	ND	< 5	12.6	15.1	ND	< 10	<5	40
Austin, Texas	1.23	1.10	ND	< 10	ND	< 5	3.9	4.6	ND	< 10	<5	20
Chicago, Illinois	1.16	1.09	ND	< 10	ND	< 5	8.9	9.5	ND	< 10	15	35
Cincinnati, Ohio	1.28	1.13	ND	< 10	ND	< 5	7.2	10.8	ND	< 10	10	25
New York, New York	1.14	1.08	ND	< 10	ND	< 5	7.0	9.5	ND	< 10	5	30
Sacramento, Calif.	1.20	1.11	ND	< 10	ND	< 5	2.4	3.8	ND	< 10	5	10
Salt Lake City, Utah (Sampling date, Nov. 9, 1960)	1.22	1.10	ND	< 10	ND	< 5	4.1	6.2	ND	< 10	20	30
Spokane, Washington	1.12	1.11	ND	< 10	ND	< 5	7.5	12.2	ND	< 10	15	45
St. Louis, Missouri	1.30	1.22	ND	< 10	ND	< 5	15.1	19.5	ND	< 10	25	35

TABLE 2.—RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program
Processed Milk Area Sampling Stations

October 1960

(Radioactivity in μμc/liter)

Area	Calcium (grams/liter)		Strontium-89		Strontium-90		Cesium-137	
	October	Average** to date	October	Average** to date	October	Average** to date	October	Average** to date
Albuquerque, N Mex.	1.05	1.11	ND	<5	2	4	ND	< 5
Atlanta, Ga.	1.22	1.23	ND	<5	10	11	ND	< 5
Austin, Texas	*	1.13	*	<5	*	2	*	5
Baltimore, Md.	1.20	1.12	ND	<5	8	7	ND	< 5
Boston, Mass.	1.22	1.18	ND	<5	10	12	ND	15
Buffalo, N. Y.	1.12	1.17	ND	<5	4	7	ND	5
Burlington, Vt.	1.23	1.19	ND	<5	6	9	ND	10
Charleston, S. C.	1.24	1.22	ND	<5	12	11	ND	10
Charleston, W. Va.	1.19	1.16	ND	<5	9	9	ND	< 5
Charlotte, N. C.	1.28	1.21	ND	<5	12	12	ND	10
Chattanooga, Tenn.	1.31	1.29	ND	<5	11	11	ND	< 5
Chicago, Ill.	1.18	1.13	ND	<5	4	6	ND	< 5
Cincinnati, O.	1.20	1.17	ND	<5	6	8	ND	< 5
Cleveland, O.	1.23	1.13	ND	<5	6	8	ND	< 5
Dallas, Texas	1.23	1.23	ND	<5	6	6	ND	< 5
Denver, Colo.	1.10	1.10	ND	<5	5	6	10	10
Detroit, Mich.	1.21	1.15	ND	<5	5	7	ND	< 5
Des Moines, Iowa	1.12	1.04	ND	<5	7	7	20	20
Grand Rapids, Mich.	1.26	1.22	ND	<5	7	8	ND	< 5
Hartford, Conn.	1.24	1.16	ND	<5	8	9	ND	10
Helena, Mont.	0.96	1.05	ND	<5	8	7	ND	15
Honolulu, Hawaii	1.10	1.06	ND	<5	5	5	20	35
Indianapolis, Ind.	1.20	1.17	ND	<5	6	6	ND	< 5
Idaho Falls, Idaho	1.15	1.06	ND	<5	5	5	10	25
Jackson, Miss.	1.30	1.26	ND	<5	10	11	ND	< 5
Kansas City, Mo.	1.02	1.07	ND	<5	8	8	10	10
Laramie, Wyo.	0.99	1.05	ND	<5	4	5	ND	< 5
Las Vegas, Nev.	0.97	1.05	ND	<5	2	2	ND	< 5
Little Rock, Ark.	1.22	1.21	ND	<5	12	13	ND	< 5
Louisville, Ky.	1.21	1.18	ND	<5	8	8	ND	< 5
Manchester, N. H.	1.23	1.22	ND	<5	8	12	ND	30
Memphis, Tenn.	1.23	1.22	ND	<5	10	12	ND	< 5
Milwaukee, Wis.	1.12	1.14	ND	<5	6	6	ND	< 5
Minneapolis, Minn.	1.11	1.03	ND	<5	8	9	ND	< 5
New Orleans, La.	1.30	1.25	ND	<5	12	15	ND	< 5
New York, N. Y.	1.14	1.11	ND	<5	8	9	ND	10
Norfolk, Va.	1.23	1.18	ND	<5	9	9	ND	< 5
Oklahoma City, Okla.	1.21	1.17	ND	<5	8	8	ND	< 5
Omaha, Nebr.	1.11	1.05	ND	<5	5	7	ND	< 5
Palmer, Alaska	1.10	1.07	ND	<5	8	7	ND	< 5
Philadelphia, Pa.	1.17	1.14	ND	<5	6	9	ND	10
Phoenix, Ariz.	1.00	1.00	ND	<5	2	4	30	20
Pittsburgh, Pa.	1.20	1.21	ND	<5	10	13	ND	10
Portland, Me.	1.21	1.14	ND	<5	10	12	ND	20
Portland, Ore.	1.16	1.10	ND	<5	9	10	20	45
Providence, R. I.	1.24	1.17	ND	<5	10	12	ND	10

See footnotes at end of table.

TABLE 2.–RADIOACTIVITY IN MILK–Con.

Public Health Service Milk Monitoring Program
Processed Milk Area Sampling Stations

October 1960

(Radioactivity in μμc/liter)

Area	Calcium (grams/liter)		Strontium-89		Strontium-90		Cesium-137	
	October	Average** to date	October	Average** to date	October	Average** to date	October	Average** to date
Sacramento, Calif.	1.01	1.03	ND	<5	5	5	ND	<5
Salt Lake City, Utah	0.94	1.08	ND	<5	4	6	ND	<5
San Francisco, Calif.	1.15	1.09	ND	<5	4	4	ND	10
San Juan, P.R.	1.22	1.15	ND	<5	3	4	ND	<5
Seattle, Wash.	1.06	1.08	ND	<5	6	9	30	45
Spokane Wash.	1.08	1.06	ND	<5	5	7	30	30
St. George, Utah	1.09	1.01	ND	<5	3	5	ND	<5
St. Louis, Mo.	1.08	1.04	ND	<5	6	6	50	50
Syracuse, N. Y.	1.20	1.22	ND	<5	6	7	ND	10
Tampa, Fla.	1.24	1.24	ND	<5	6	5	75	80
Trenton, N. J.	1.26	1.17	ND	<5	8	8	ND	5
Washington, D. C.	1.12	1.13	ND	<5	6	8	ND	<5
Wichita, Kansas	1.00	1.07	ND	<5	4	6	ND	<5
Wilmington, Del.	1.21	1.20	ND	<5	8	9	ND	10

ND--No detectable activity.

*Sample lost during analysis.

**Because this program was initiated in 1960 and sampling stations necessarily became operative in a staggered sequence, the averages shown represent all samples taken to date. Averages will normally be for the latest 12 month period after sampling began. For the October data, the average covers a period of one to eight months.

RADIOACTIVITY IN MILK

Health and Safety Laboratory
U. S. Atomic Energy Commission

The data for the Atomic Energy Commission Health and Safety Laboratory's routine milk monitoring program at four locations in the United States for July and August 1960 are presented in table 1. Data for previous months appear in Radiological Health Data, Volume I, Numbers 1, 2, 3, 5, 7 and 8.

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TABLE 1.–STRONTIUM-90 AND CALCIUM IN MILK SAMPLES

Atomic Energy Commission

Sampling station Month 1960	Strontium-90			Calcium	
	μμc/liter	μμc/kg	μμc/gmCa	gm/liter	gm/kg
Perry, N. Y. (Powdered milk)					
July		69.8	7.7		9.0
August		78.8	8.6		9.1
New York City (Liquid milk)					
July	10.2		9.8	1.0	
August	8.7		8.6	1.0	
Mandan, N. Dakota (Powdered buttermilk)					
July		80.8	9.6		8.4
August		99.2	10.0		9.9
Honolulu, Hawaii (Liquid milk)					
July*	3.7		3.6	1.0	
	2.5		2.4	1.0	
August*	4.2		3.8	1.1	
	2.6		2.5	1.1	

*Two results per month representing milk from two different dairies.

SECTION IV.—WATER

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK

The National Water Quality Network was established under the provision of Section 4 (c) of Public Law 660, which states "...The Surgeon General shall ...collect and disseminate basic data ...(relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State and local health agencies, was started in October 1957. At present there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses; some of these stations are on interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately a total of 250 to 300 stations will be in operation. A few of the more recently established stations have not begun to report radioactivity.

Samples of water are examined for chemical, physical and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some continuous composite samples for 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The radioactivity levels of dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occuring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the presence of the same nuclides. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River. The results are reported in micromicrocuries per liter and are shown for each station on a given river.

While beta determinations for the first two years of the Network operation have been conducted weekly on each sample, the alpha determinations are reported generally on a composite sample of more than one week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data are reported on three-month composite samples, with 1/3 of the stations being covered each month. All the data reported in table 1 represent the average of all information available for the month indicated.

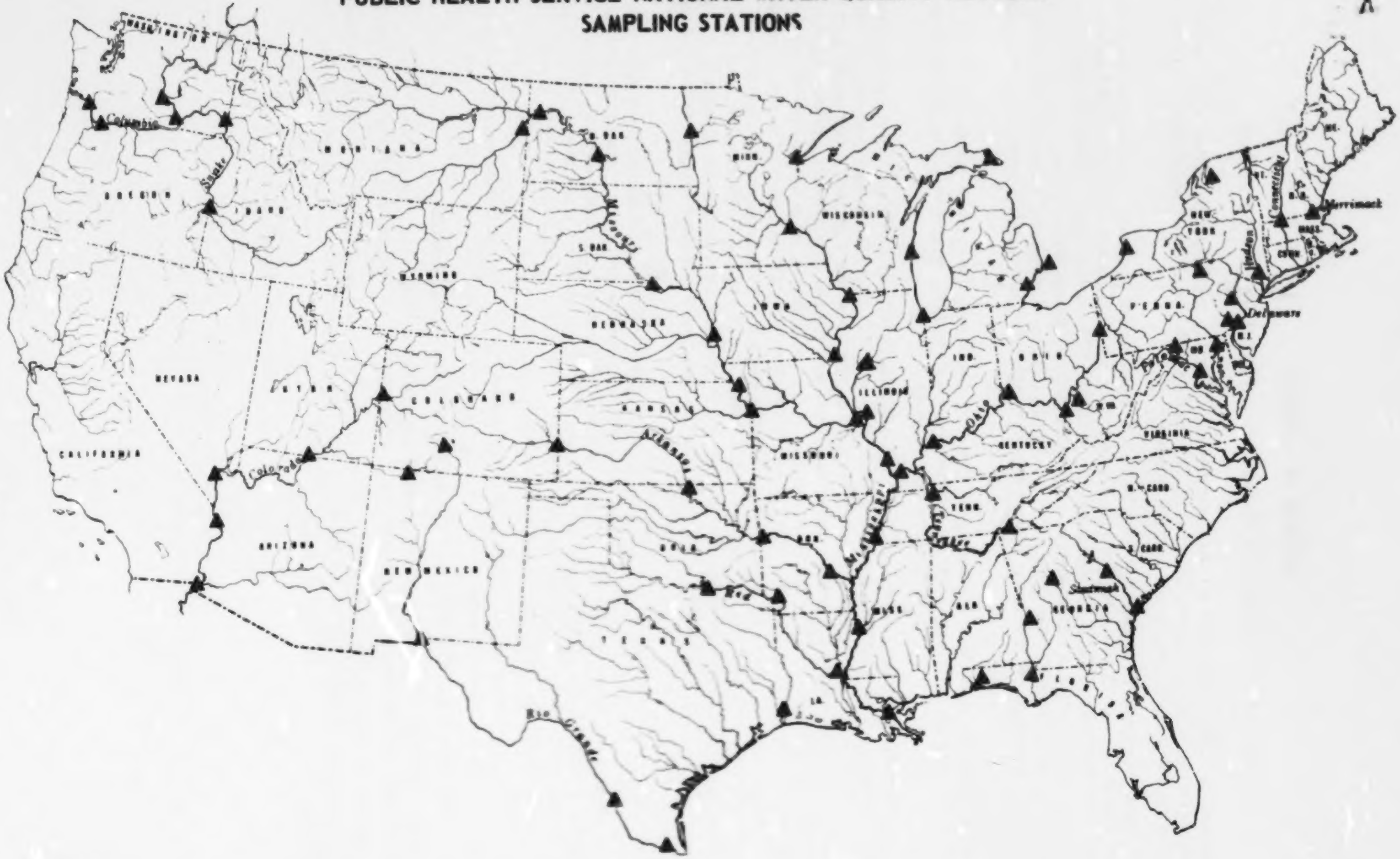
Strontium-90 data reported are the results of determinations on composite samples for a three-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

1. "National Water Quality Network Annual Compilation of Data," PHS Publication. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.50.

2. "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, at the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167-169.

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS


WASHINGTON
Columbia
OREGON
Snake
IDAHO
MONTANA
N. DAK
S. DAK
Missouri
WYOMING
NEBRASKA
NEVADA
UTAH
COLORADO
KANSAS
CALIFORNIA
Colorado
ARIZONA
NEW MEXICO
Arkansas
OKLA
Red
TEXAS
Rio Grande
MINN
WISCONSIN
IOWA
ILLINOIS
MISSOURI
ARK
Mississippi
LA
MISS
ALA
TENN
Tennessee
KENTUCKY
Ohio
IND
OHIO
W. VA
VIRGINIA
N. CARO
S. CARO
GEORGIA
Savannah
FLORIDA
PENNA
Potomac
NEW YORK
Hudson
Delaware
Connecticut
MASS
CONN
Merrimack
ME

As of June 30, 1960

FIGURE 1

TABLE 1.–RADIOACTIVITY IN RAW SURFACE WATERS

Public Health Service National Water Quality Network

(Average concentrations in μμc/liter)

Station	Quarter ending Sept. 30, 1960	September 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
ANIMAS RIVER							
Cedar Hill, N. Mex.	0.4	0	24	24	2	22	24
APALACHICOLA RIVER							
Chattahoochie, Fla.	0.5	0	0	0	0	0	0
ARKANSAS RIVER							
Coolidge, Kans.	0.8	-	-	-	-	-	-
CHATTAHOOCHIE RIVER							
Atlanta, Ga.	-	0	0	0	0	0	0
Columbus, Ga.	-	0	0	0	0	0	0
COLORADO RIVER							
Loma, Colo.	-	0	8	8	1	20	21
Page Ariz.	-	47	34	81	25	40	65
Hoover Dam, Ariz.-Nev.	1.0	1	16	17	0	0	0
Yuma, Ariz.	-	0	7	7	1	7	8
COLUMBIA RIVER							
Pasco, Wash.	-	35	513	548	-	-	-
Wenatchee, Wash.	-	0	0	0	-	-	-
Bonneville Dam, Ore.	-	2	291	293	-	-	-
Clatskanie, Ore.	0.3	-	-	-	-	-	-
DELAWARE RIVER							
Martin's Creek, Pa.	-	2	0	2	-	-	-
Philadelphia, Pa.	-	0	0	0	3	1	4
ESCAMBIA RIVER							
Century, Fla.	-	16	0	16	3	1	4
GREAT LAKES							
Gary, Ind.	0.5	0	0	0	1	0	1
Duluth, Minn.	-	0	0	0	0	1	1
Detroit, Mich.	-	0	2	2	0	1	1
Buffalo, N. Y.	-	0	0	0	-	-	-
Milwaukee, Wisc.	-	< 1	5	5	0	1	1
HUDSON RIVER							
Poughkeepsie, N. Y.	0.1	0	0	0	0	1	1
ILLINOIS RIVER							
Peoria, Ill.	0.3	0	2	2	1	3	4
KANAWHA RIVER							
Winfield Dam, W. Va.	-	0	3	3	0	0	0

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TABLE 1.--RADIOACTIVITY IN RAW SURFACE WATERS--Con.

Public Health Service National Water Quality Network

(Average concentrations in μμc/liter)

Station	Quarter ending Sept. 30, 1960	September 1960					
		Beta activity			Alpha activity		
	Strontium-90	Susp.	Diss.	Total	Susp.	Diss.	Total
MISSISSIPPI RIVER							
Red Wing, Minn.	1.4	-	-	-	-	-	-
Dubuque, Iowa	-	0	0	0	0	1	1
East St. Louis, Ill.	-	0	0	0	0	3	3
Cape Girardeau, Mo.	0.9	13	3	16	1	8	9
West Memphis, Ark.	-	5	4	9	1	2	3
Delta, La.	-	0	0	0	-	-	-
New Orleans, La.	-	0	14	14	0	2	2
MISSOURI RIVER							
Williston, N. D.	-	7	0	7	-	-	-
Yankton, S. D.	-						
Omaha, Nebr.	-	10	5	15	-	-	-
St. Joseph, Mo.	-	14	1	15	-	-	-
Kansas City, Kans.	-	7	5	12	14	6	20
St. Louis, Mo.	1.2	22	0	22	-	-	-
OHIO RIVER							
East Liverpool, Ohio	0.4	-	-	-	-	-	-
Wheeling, W. Va.	0.5	0	2	2	1	< 1	2
Huntington, W. Va.	-	2	6	8	0	0	0
Cincinnati, Ohio	-	0	7	7	0	1	1
Evansville, Ind.	-	0	0	0	-	-	-
Cairo, Ill.	0.4	-	-	-	-	-	-
RED RIVER, NORTH							
Grand Forks, N. D.	(*)	6	16	22	< 1	3	3
RED RIVER, SOUTH							
Denison, Tex.	-	0	0	0	-	-	-
Index, Ark.	-	2	11	13	4	2	6
Alexandria, La.	1.1	-	-	-	-	-	-
RIO GRANDE RIVER							
El Paso, Tex.	-	4	3	7	2	21	23
Brownsville, Tex.	0.3	0	0	0	-	-	-
SABINE RIVER							
Ruliff, Tex.	-	< 1	1	1	1	< 1	2
ST. CLAIR RIVER							
Port Huron, Mich.	0.6	0	24	24	0	1	1
ST. LAWRENCE RIVER							
Massena, N. Y.	-	< 1	3	4	0	< 1	< 1
ST. MARY'S RIVER							
Sault Ste. Marie, Mich.	-	0	0	0	0	0	0

See footnotes at end of table.

TABLE 1.--RADIOACTIVITY IN RAW SURFACE WATERS--Con.

Public Health Service National Water Quality Network

(Average concentrations in μμc/liter)

Station	Quarter ending Sept. 30, 1960	September 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
SCHUYLKILL RIVER							
Philadelphia, Pa.	-	0	0	0	1	0	1
SAVANNAH RIVER							
Port Wentworth, Ga.	0.8	0	75	75	0	0	0
SNAKE RIVER							
Wawawai, Wash.	0.5	-	-	-	-	-	-
SUSQUEHANNA RIVER							
Sayre, Pa.	0.3	0	2	2	< 1	1	1
Conowingo, Md.	0.3	0	4	4	0	< 1	< 1
TENNESSEE RIVER							
Chattanooga, Tenn.	0.6	0	12	12	1	1	2
YELLOWSTONE RIVER							
Sidney, Mont.	-	0	0	0	-	-	-

*Insufficient sample for analysis.

SECTION V.—OTHER DATA

EXTERNAL GAMMA ACTIVITY

Public Health Service Radiation Surveillance Network

Portable survey instruments are available at stations of the Radiation Surveillance Network for recording levels of external gamma radiation. Measurements are made daily approximately three feet above the ground. These readings are not precise but are sufficiently accurate to illustrate any significant variations above background. The differences among the values shown in the following table are within the variance anticipated due to differences in normal background and in instrument response characteristics.

TABLE 1.--EXTERNAL GAMMA ACTIVITY

Public Health Service Radiation Surveillance Network

October 1960

Station Location	Average (mr/hr)	Station Location	Average (mr/hr)
Alaska, Anchorage	0.01	Mississippi, Pascagoula	(*)
Alaska, Fairbanks	(*)	Missouri, Jefferson City	0.01
Alaska, Juneau	0.02	Montana, Helena	0.03
Arizona, Phoenix	0.01	New Jersey, Trenton	(*)
Arkansas, Little Rock	0.01	New Mexico, Santa Fe	0.04
California, Berkeley	0.01	New York, Albany	0.01
California, Los Angeles	0.01	North Carolina, Gastonia	0.02
Colorado, Denver	(*)	Ohio, Cincinnati	(*)
Connecticut, Hartford	0.01	Oklahoma, Oklahoma City	0.02
District of Columbia	0.02	Oklahoma, Ponca City	0.04
Florida, Jacksonville	0.01	Oregon, Portland	0.02
Georgia, Atlanta	(*)	Pennsylvania, Harrisburg	0.01
Hawaii, Honolulu	0.03	Rhode Island, Providence	0.02
Idaho, Boise	0.01	South Carolina, Columbia	0.02
Illinois, Springfield	0.01	South Dakota, Edgemont	(*)
Indiana, Indianapolis	0.01	South Dakota, Pierre	0.02
Iowa, Iowa City	0.01	Texas, Austin	0.01
Kansas, Topeka	0.02	Texas, El Paso	0.02
Louisiana, New Orleans	0.01	Utah, Salt Lake City	0.02
Maryland, Baltimore	0.02	Virginia, Richmond	0.01
Massachusetts, Lawrence	0.02	Washington, Seattle	0.02
Michigan, Lansing	0.02	Wyoming, Cheyenne	0.02
Minnesota, Minneapolis	0.01		

* No data received

SOIL DATA

Argonne National Laboratory
U. S. Atomic Energy Commission

Fission product radioactivity at the Argonne National Laboratory, Lemont, Illinois for September 1960 has been reported by Dr. Philip F. Gustafson. Previous data has been reported in Radiological Health Data, Volume I, Numbers 1, 2, 4, 9 and Volume II, Number 1.

Isotope	September 30, 1960 (mc/mi^2)
Zr^{95}--Nb^{95}	0
Cs^{137}	195
Ru^{106}	755
Ce^{144}	1100
Total	2050
Dose-rate (μrads/hr) *	1.33

* Calculated dose-rate at one meter above ground surface. No correction is made for shielding effect of structures.

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The United States Atomic Energy Commission is providing data on environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis. The data are from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Radiological Health Data, Volume I, Numbers 3 and 9, and Volume II, Numbers 1 and 2, contained summaries for 16 installations. Reports on four of the installations, covering the second and third quarters of 1960, follow.

MOUND LABORATORY

Monsanto Chemical Company
Miamisburg, Ohio

Issued August and December 1960

Environmental levels of radioactivity at Mound Laboratory for 1959 and the first quarter 1960 were reported in Radiological Health Data, Volume I, Number 8. The following report presents the data for the second and third quarters of 1960.

During the period covered by this report, no radioactive materials were used which contributed any measurable gamma or hard beta emitters to the environment.

Polonium, plutonium and tritium are possible air contaminants; polonium and tritium are possible river water contaminants.

Water Monitoring

Liquid radioactive waste materials from polonium work at the Laboratory are processed in a special waste disposal plant. Here, levels of radioactivity are reduced to an acceptable concentration for discharge into the Great Miami River. Liquid waste from plutonium work is small in volume. It is handled separately as a packaged waste and not discharged to the river. The purification of helium-3 yeilds small quantities of tritium. Liquid waste from this work, also small in volume, is treated separately (diluted with water when necessary) to assure that the radioactive content is within the maximum permissible concentration prior to discharge into the Great Miami River.

Samples are collected routinely each week from the Laboratory effluent stream at the point of discharge and in the Great Miami River downstream to a distance of five miles. Once each quarter, river water samples are collected at various locations between Franklin, Ohio, and Elizabethtown, Ohio, where the Great Miami River enters the Ohio River. A weekly water sample is also collected from a drainage ditch which runs through the plant site. This ditch carries off all storm sewer water, which eventually empties into the river. The treated liquid tritium waste is discharged into the storm sewers; the waste disposal plant effluent is discharged directly into the river via a closed sewer line. All of the samples collected from the river are analyzed to determine the polonium concentration. The drainage ditch sample and part of the river samples are analyzed for tritium concentration.

The data presented in table 1 indicate that the concentrations of polonium and tritium in the Great Miami River are well within the maximum permissible continuous concentration.

Refer to the "Water Sample Locations," figure 1, to determine the location of the data presented in table 1.

Air Monitoring

Monitoring of the environmental air for tritium concentration by means of a continuous air monitor mounted in a panel truck was performed routinely out to a distance of five miles from the Laboratory. The concentration of this isotope in the environment has been immeasurable to date.

Monitoring for possible polonium and plutonium in the environment is accomplished by particulate air sampling equipment also mounted in the panel truck used for tritium air sampling. A long-lived gross alpha determination on filter paper samples was made only after sufficient time had elapsed after collection to permit the decay of short-lived daughter products of radon and thoron.

The concentration of alpha activity detected in the environment was very low. At the low concentrations detected, the isotopes of polonium and plutonium are not distinguishable from each other or from the natural background radioactivity in the air. The polonium effluent stack monitoring program for these quarters has shown essentially no detectable polonium in the environment due to the operations at Mound Laboratory should be expected.

Comparing the gross alpha detected in the air to the maximum permissible continuous concentration for plutonium in the environment, and assuming that all alpha activity detected is plutonium, it is found that the average plutonium concentration is well within permissible concentration; however, it is a significant per cent of the permissible concentration. In order to determine the impact of the Mound Laboratory plutonium work on the environment, it is pointed out that the natural background concentration of alpha contamination in the air in southwestern Ohio is in the range of, and frequently exceeds, the very low permissible concentration for plutonium. The normal gross alpha (long-lived) count in the environment is usually a very significant per cent of, and frequently exceeds, the permitted alpha count for plutonium if the total count is attributed to plutonium. The impact of plutonium work at Mound Laboratory is also placed in proper focus by referring to our plutonium stack monitoring data. During the third quarter of 1960, the average concentration of plutonium in air discharged from the stack was well within the permissible concentration for environmental air. For this reason, and the fact that the air is discharged to the environment from a 200 foot stack at a high velocity yeilding a high dilution factor, the plutonium operations (as well as the polonium work) have contributed an insignificant burden to the radioactivity normally present in the atmosphere.

TABLE 1.--SUMMARY OF MONITORING FOR RADIOACTIVITY IN GREAT MIAMI RIVER

(Average concentrations in μμc/liter)

Location description	Second quarter 1960		Third quarter 1960				
	Concentration	%MPC*	Location		Number samples	Concentration	%MPC*
			Number	Description			
Polonium (all river samples):							
Mound Lab effluent	662.2		2	Mound Lab effluent	12	236	33.7
200 yards downstream	1.2	0.17	3	250 yards downstream	12	1.1	.15
250 yards downstream	.9	0.13	4	Chautauqua Rd. Bridge	11	.8	.12
300 yards downstream	.8	0.11	5	Chautauqua Dam	12	.4	.06
1 mile downstream	1.8	0.43	6	Franklin, Ohio	11	3.4	.49
2 miles downstream	2.1	0.50		Trenton, Ohio	1	N.D.	
5 miles downstream	.2	0.05		New Miami, Ohio	1	N.D.**	0
				7 miles N. of New Baltimore, Ohio	1	N.D.	0
				New Baltimore, Ohio	1	N.D.	0
				Miamitown, Ohio	1	N.D.	0
				5 miles N. of Elizabethtown, Ohio	1	N.D.	0
				Elizabethtown, Ohio	1	N.D.	0
Tritium (drainage ditch and river samples)	N.D.	0	1	Mound Lab drainage ditch	15	4.0×10^5	14
			2	Mound Lab effluent	13	N.D.	0
			4	Chautauqua Rd. Bridge	5	N.D.	0

* The values for MPC in water are 1/10 of the MPC allowed for continuous occupational exposure as given in Handbook 69, National Bureau of Standards, issued June 5, 1959.

** Not detectable by present instrumentation.

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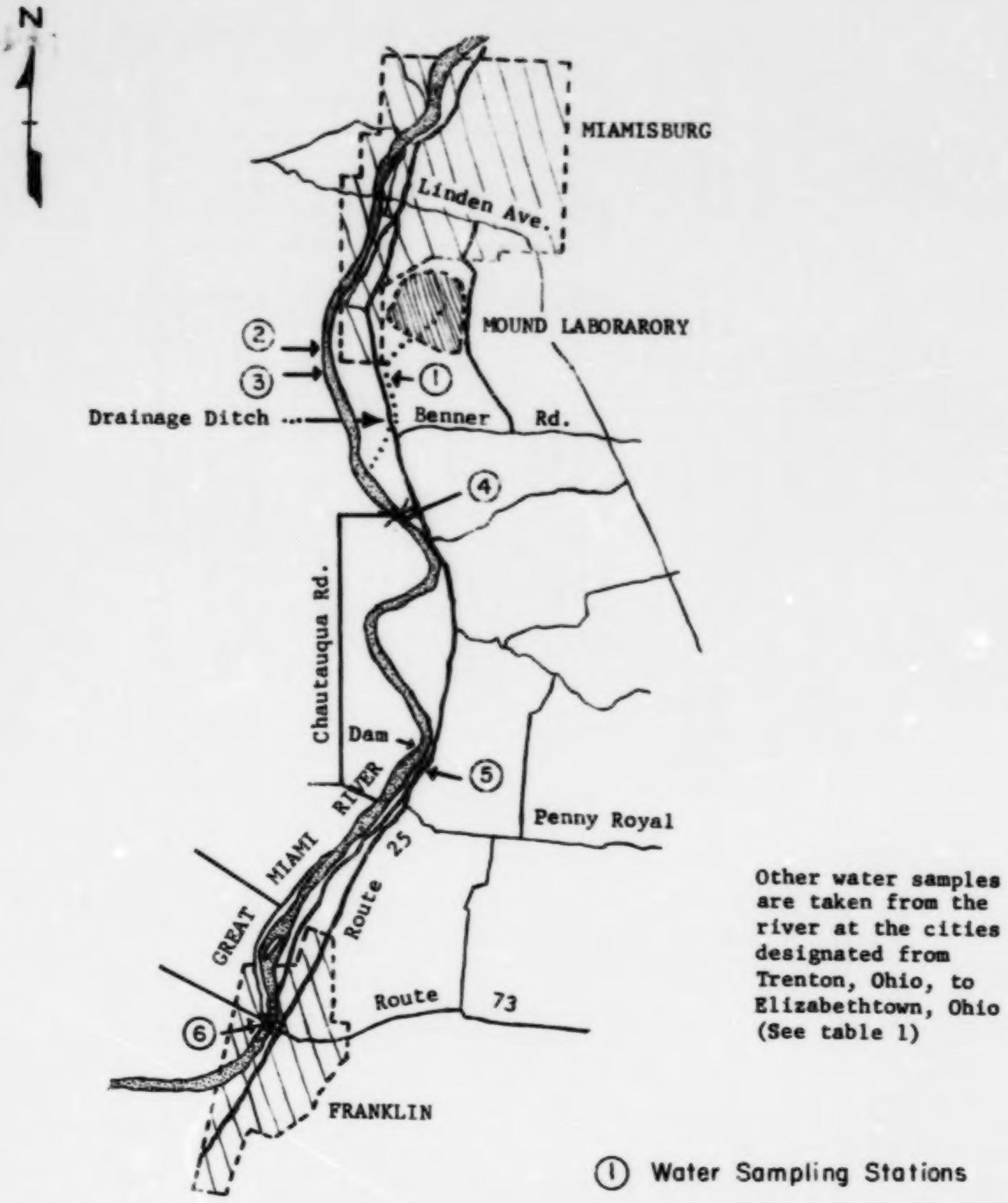

N
MIAMISBURG
Linden Ave.
MOUND LABORARORY
②
③
①
Drainage Ditch
Benner Rd.
④
Chautauqua Rd.
Dam
⑤
GREAT MIAMI RIVER
Penny Royal
Route 25
Route 73
⑥
FRANKLIN
① Water Sampling Stations

Other water samples are taken from the river at the cities designated from Trenton, Ohio, to Elizabethtown, Ohio (See table 1)

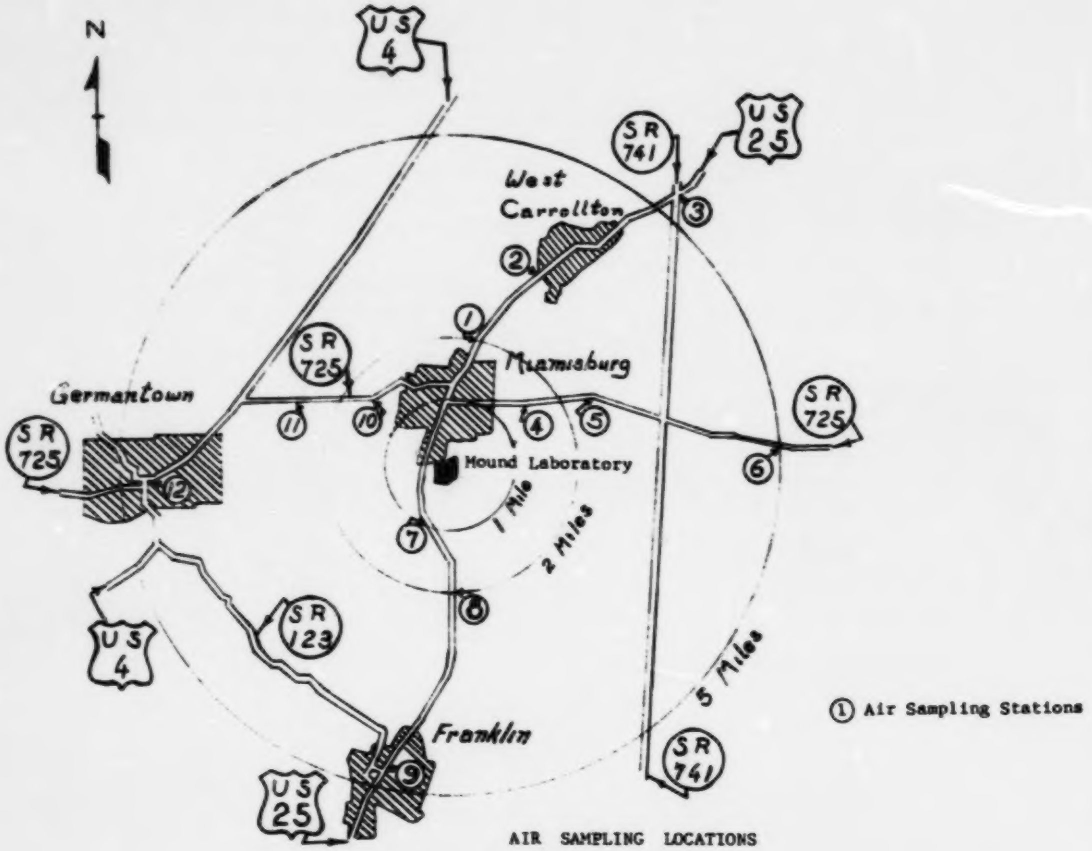
GREAT MIAMI RIVER WATER SAMPLING LOCATIONS
MOUND LABORATORY
FIGURE I

TABLE 2.--GROSS ALPHA ACTIVITY IN AIR FROM POLONIUM AND PLUTONIUM

(Not including natural background)

Distance from Mound Laboratory	Second Quarter 1960			Third Quarter 1960		
	Number sampling locations	Number samples	Average concentration ($\mu\mu c/m^3$)	Number sampling locations	Number samples	Average concentration ($\mu\mu c/m^3$)
0-5 miles	12	131	0.0270	12	81	0.0116
5-15 miles	15	15	ND	10	10	.0303
5- 30 miles				17	17	.0102
30-40 miles				9	9	.0090

ND--Not detectable by present instrumentation.


N
US 4
SR 741
US 25
West Carrollton
③
②
①
SR 725
Miamisburg
Germantown
⑪
⑩
④
⑤
SR 725
SR 725
Mound Laboratory
⑥
⑫
⑦
1 Mile
2 Miles
⑧
US 4
SR 123
5 Miles
Franklin
⑨
SR 741
US 25
① Air Sampling Stations

AIR SAMPLING LOCATIONS
MOUND LABORATORY

FIGURE 2

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OAK RIDGE NATIONAL LABORATORY

Union Carbide Nuclear Company
Oak Ridge, Tennessee

Issued November 1960

Environmental levels of radioactivity at Oak Ridge National Laboratory (ORNL) for 1959 and the first quarter 1960 were reported in the Radiological Health Data, Volume I, Number 9. The following report presents a summary of the data for the second and third quarters of 1960.

Radioactive waste materials arising from the operation of atomic energy installations at the ORNL are collected, treated and disposed of according to their physical states. Air that may have become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by filtration, scrubbing and/or precipitation. Liquid wastes which contain long-lived fission products are confined in storage tanks or are released to earthen pits located in the Conasauga shale formation. Low level liquid wastes are discharged after preliminary treatment to the surface streams. Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

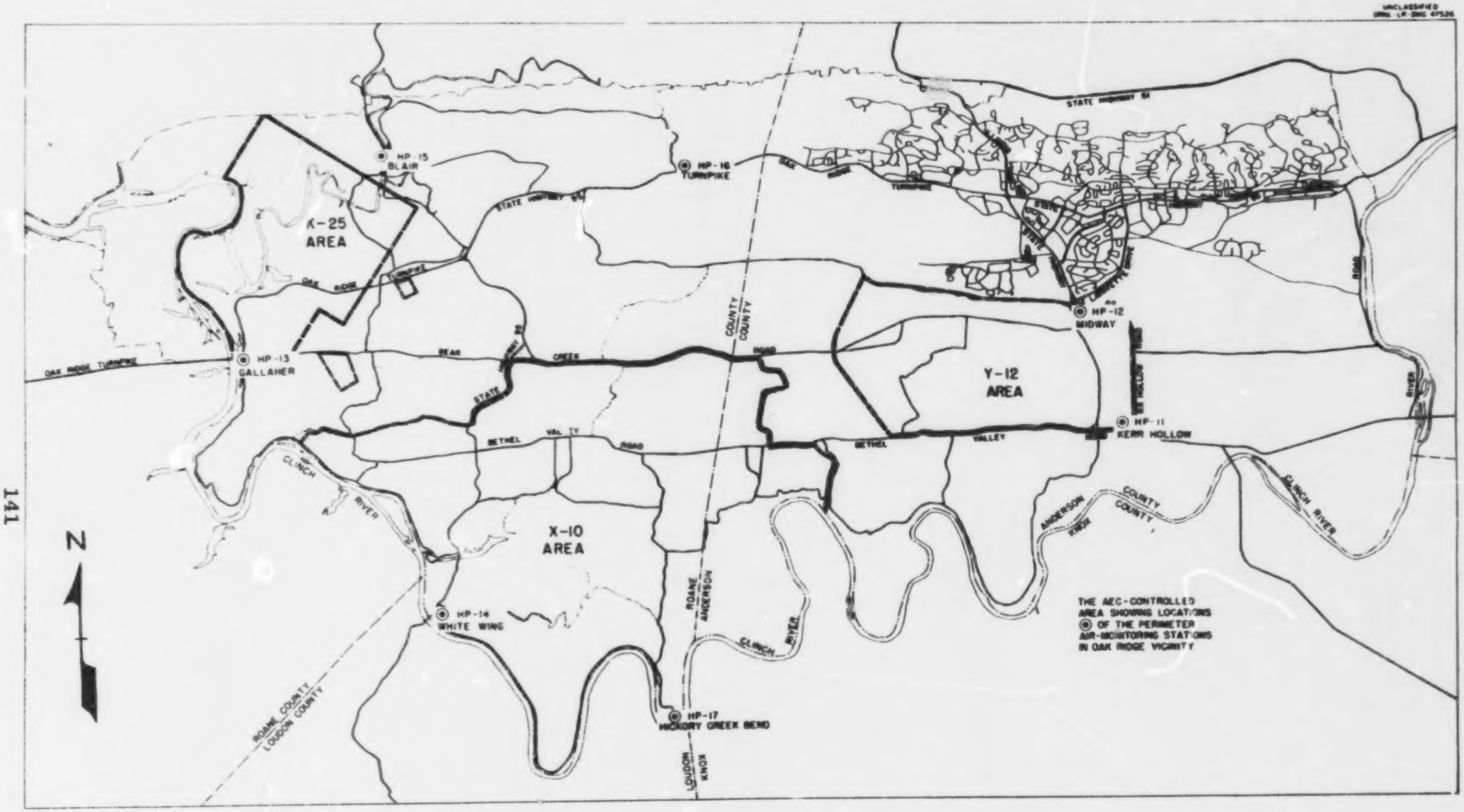
Air Monitoring

Atmospheric contamination and fallout occuring in the general environment of east Tennessee are monitored by two systems of sampling stations. One system consists of seven stations which encircle the plant areas (figure 1) and provides data for evaluating the impact of ORNL operations on the immediate environment. A second system consists of eight stations encircling the ORNL area at distances of from 12 to 120 miles (figure 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Table 1 presents the data from the air monitoring program for the second and third quarters of 1960.

TABLE 1.—CONTINUOUS AIR MONITORING FILTER DATA

(Average concentrations in $\mu\mu c/m^3$)

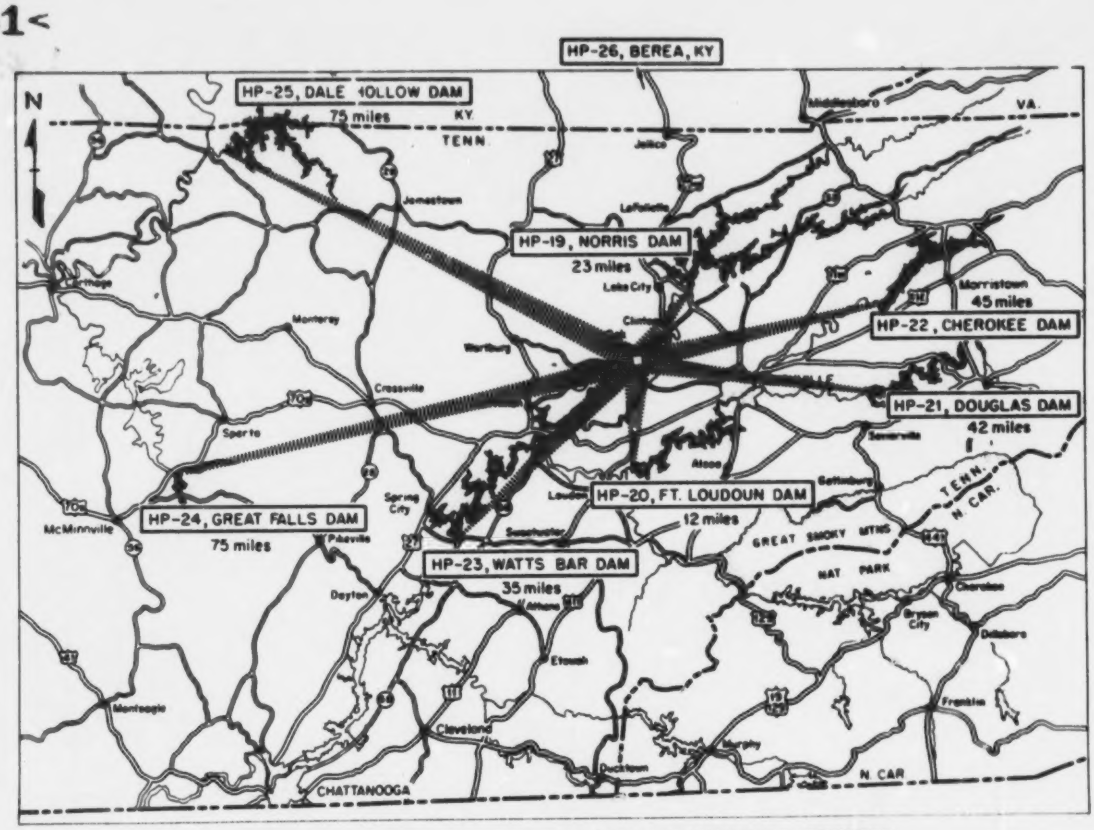
Station number	Second quarter 1960		Third quarter 1960	
	Number samples	Gross activity	Number samples	Gross activity
Perimeter stations:				
HP-11	13	0.149	14	0.103
HP-12	13	.195	14	.099
HP-13	13	.141	14	.060
HP-14	13	.104	14	.066
HP-15	13	.242	14	.111
HP-16	12	.130	14	.078
HP-17	13	.172	14	.078
Average		0.162		0.085
Remote stations:				
HP-19	13	0.177	13	0.082
HP-20	13	.191	13	.087
HP-21	13	.158	13	.080
HP-22	13	.154	13	.072
HP-23	13	.173	13	.088
HP-24	13	.189	13	.097
HP-25	13	.160	11	.066
HP-26	10	.093	12	.062
Average		0.162		0.080


UNCLASSIFIED
ORNL-LR-DWG 47536
STATE HIGHWAY 61
HP-15 BLAIR
HP-16 TURNPIKE
OAK RIDGE TURNPIKE
STATE HIGHWAY 95
K-25 AREA
OAK RIDGE TURNPIKE
HP-13 GALLAHER
BEAR CREEK ROAD
STATE HIGHWAY 95
COUNTY
COUNTY
HP-12 MIDWAY
Y-12 AREA
HP-11 KERR HOLLOW
BETHEL VALLEY ROAD
BETHEL VALLEY
ROAD
RIVER
CLINCH RIVER
X-10 AREA
HP-14 WHITE WING
ROANE COUNTY
LOUDON COUNTY
ROANE
ANDERSON
CLINCH RIVER
HP-17 HICKORY CREEK BEND
LOUDON
KNOX
ANDERSON COUNTY
KNOX COUNTY
CLINCH RIVER
N
THE AEC-CONTROLLED AREA SHOWING LOCATIONS ◉ OF THE PERIMETER AIR-MONITORING STATIONS IN OAK RIDGE VICINITY

PERIMETER AIR MONITORING STATIONS

OAK RIDGE NATIONAL LABORATORY

FIGURE 1


HP-26, BEREA, KY
HP-25, DALE HOLLOW DAM
75 miles
KY.
TENN.
VA.
N
Middlesboro
Jellico
Jamestown
LaFollette
HP-19, NORRIS DAM
23 miles
Lake City
Clinton
Morristown
45 miles
HP-22, CHEROKEE DAM
Monterey
Wartburg
Crossville
HP-21, DOUGLAS DAM
42 miles
Sevierville
Sparta
Alcoa
Gatlinburg
Spring City
Loudon
HP-20, FT. LOUDOUN DAM
12 miles
TENN.
N. CAR.
McMinnville
HP-24, GREAT FALLS DAM
75 miles
Pikeville
Sweetwater
GREAT SMOKY MTNS
NAT PARK
HP-23, WATTS BAR DAM
35 miles
Dayton
Athens
Cherokee
Bryson City
Dillsboro
Etowah
Monteagle
Cleveland
Franklin
Murphy
Ducktown
N. CAR.
CHATTANOOGA

STATION SITES FOR REMOTE AIR MONITORING SYSTEM
OAK RIDGE NATIONAL LABORATORY

FIGURE 2

Water Monitoring

Large volumes of low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and then to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for population in the neighborhood of a controlled area as recommended by the National Committee on Radiation Protection (NCRP). The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Radioactive liquid wastes are sampled at the locations as shown in figures 3 and 4. Samples are taken in Poplar and White Oak Creeks and at a number of locations in the Clinch River beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously by the United States Geological Survey to obtain dilution factors for calculating the probable concentrations of wastes in the river. Water monitoring data are tabulated in tables 2 and 3.

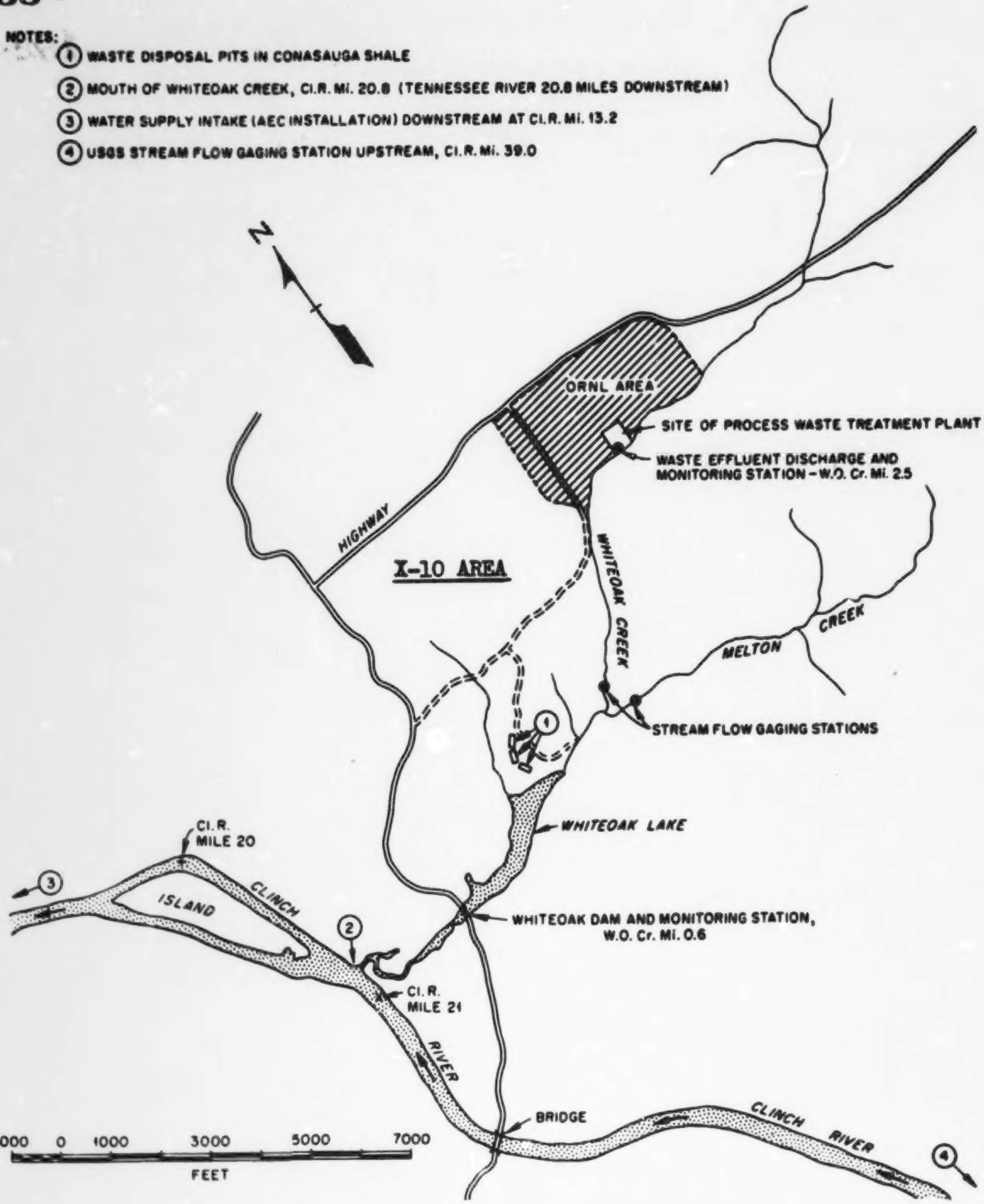
TABLE 2.–MAJOR RADIOACTIVE ELEMENTS IN THE CLINCH RIVER

(Average concentrations in $\mu\mu c$/liter)

Location	Sampling period	Sr^{90}	Ce^{144}	Cs^{137}	Ru$^{103-106}$	Co^{60}	Calculated concentrations gross beta
Upstream	Second quarter	1	0.5	ND*	ND	ND	3
(mi. 37.5)	Third quarter	1	0.6	ND	ND	ND	1
Point of entry	Second quarter	8	2.0	4.0	163	12	562
(mi. 20.8)**	Third quarter	7	1.0	5.0	63	6	215
Downstream	Second quarter	7	0.9	0.6	91	0.5	118
(mi. 4.5)	Third quarter	5	0.6	0.9	32	2	118

*Not detectable by present instrumentation.

**Values given for this location are calculated values based on the levels of waste released and the dilution afforded by the river.

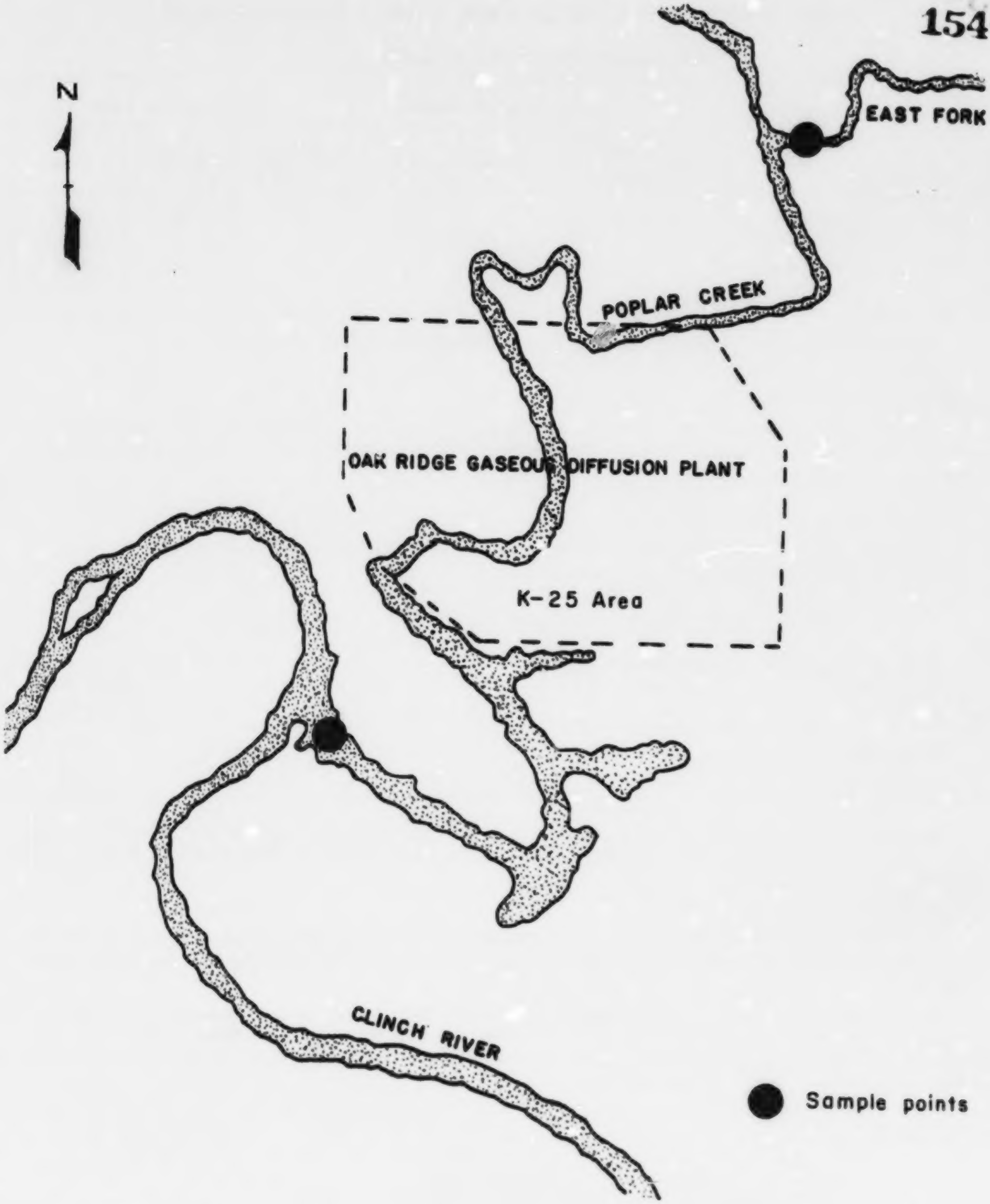


NOTES:
① WASTE DISPOSAL PITS IN CONASAUGA SHALE
② MOUTH OF WHITEOAK CREEK, Cl.R. Mi. 20.8 (TENNESSEE RIVER 20.8 MILES DOWNSTREAM)
③ WATER SUPPLY INTAKE (AEC INSTALLATION) DOWNSTREAM AT Cl.R. Mi. 13.2
④ USGS STREAM FLOW GAGING STATION UPSTREAM, Cl.R. Mi. 39.0

N
ORNL AREA
SITE OF PROCESS WASTE TREATMENT PLANT
WASTE EFFLUENT DISCHARGE AND MONITORING STATION - W.O. Cr. Mi. 2.5
HIGHWAY
X-10 AREA
WHITEOAK CREEK
MELTON CREEK
STREAM FLOW GAGING STATIONS
①
WHITEOAK LAKE
Cl. R. MILE 20
③
ISLAND
CLINCH
②
WHITEOAK DAM AND MONITORING STATION, W.O. Cr. Mi. 0.6
Cl. R. MILE 21
RIVER
BRIDGE
CLINCH RIVER
④
1000 0 1000 3000 5000 7000
FEET

LOCATION MAP
OAK RIDGE NATIONAL LABORATORY

FIGURE 3


N
EAST FORK
POPLAR CREEK
OAK RIDGE GASEOUS DIFFUSION PLANT
K-25 Area
CLINCH RIVER
● Sample points

WATER SAMPLING LOCATIONS
OAK RIDGE NATIONAL LABORATORY

FIGURE 4

TABLE 3.--CONCENTRATION OF RADIOACTIVITY IN POPLAR CREEK

(Average concentrations in $\mu\mu$c/liter)

Location	Second quarter 1960			Third quarter 1960		
	Number samples	Uranium	Beta	Number samples	Uranium	Beta
Upstream (East Fork)	13	57	71	13	19	65
Downstream (Outfall)	13	6	399	13	9	190

Normal sampling frequency: Continuous sampling composited over one week.

External Gamma Activity

External gamma radiation levels are measured monthly at five locations in the Oak Ridge area. Measurements are taken with a GM survey instrument at a distance of three feet above ground. The results are tabulated in table 4.

TABLE 4.—EXTERNAL GAMMA RADIATION LEVELS

(Average levels in mr/hr)

Period 1960	Location				
	Solway Gate	Y-12 East Portal	Newcomb Road Oak Ridge	Gallaher Gate	White Wing Gate
Second quarter	0.014	0.014	0.014	0.014	0.014
Third quarter	.014	.013	.014	.015	.017

External gamma radiation levels in the Oak Ridge area do not differ significantly from the average of the levels measured throughout the United States by the Public Health Service Radiation Surveillance Network.

Conclusions

From the data presented, it seems evident that the Oak Ridge Operations are contributing little to the air or ground contamination in the neighborhood of the area controlled by the Atomic Energy Commission.

Some radioactivity has been contributed to the Clinch River by the release of radioactive liquid wastes, but concentrations of radioactivity in the river are well below the maximum permissible concentration recommended by the NCRP for populations living in the vicinity of an atomic energy installation.

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PADUCAH GASEOUS DIFFUSION PLANT

Union Carbide Nuclear Company
Paducah, Kentucky

Issued December 1960

Environmental levels of radioactivity at the Paducah Gaseous Diffusion Plant for 1959 and the first quarter 1960 were reported in Radiological Health Data, Volume I, Number 9. The following report presents a summary of the data for the second and third quarters of 1960.

The Paducah Plant is a government-owned gaseous diffusion plant operated by Union Carbide Nuclear Company for the Atomic Energy Commission. The diffusion plant, with the associated uranium hexafluoride manufacturing plant and uranium metal foundry, processes large quantities of relatively pure uranium compounds. The major sources of external penetrating radiation from such materials are the daughter products, isotopes of thorium and protactinium, formed by the alpha decay and subsequent beta decay of the parent uranium. These isotopes are concentrated in the ash produced during the fluorination process. The element uranium can be a physiological hazard only if it enters the body. The chemical toxicity of the uranium materials processed at the Paducah Plant overshadows any radiation danger from this element, making it comparable as a physiological risk to lead, mercury or other well known heavy metals.

Uranium is a rather expensive material, and this represents a great incentive to recover as much in any situation as is economically feasible. The added desire to maintain a wholesome relationship with neighboring communities and individuals makes it essential that all waste air be exhausted through filters and that all effluent waters be maintained at extremely low concentrations of uranium.

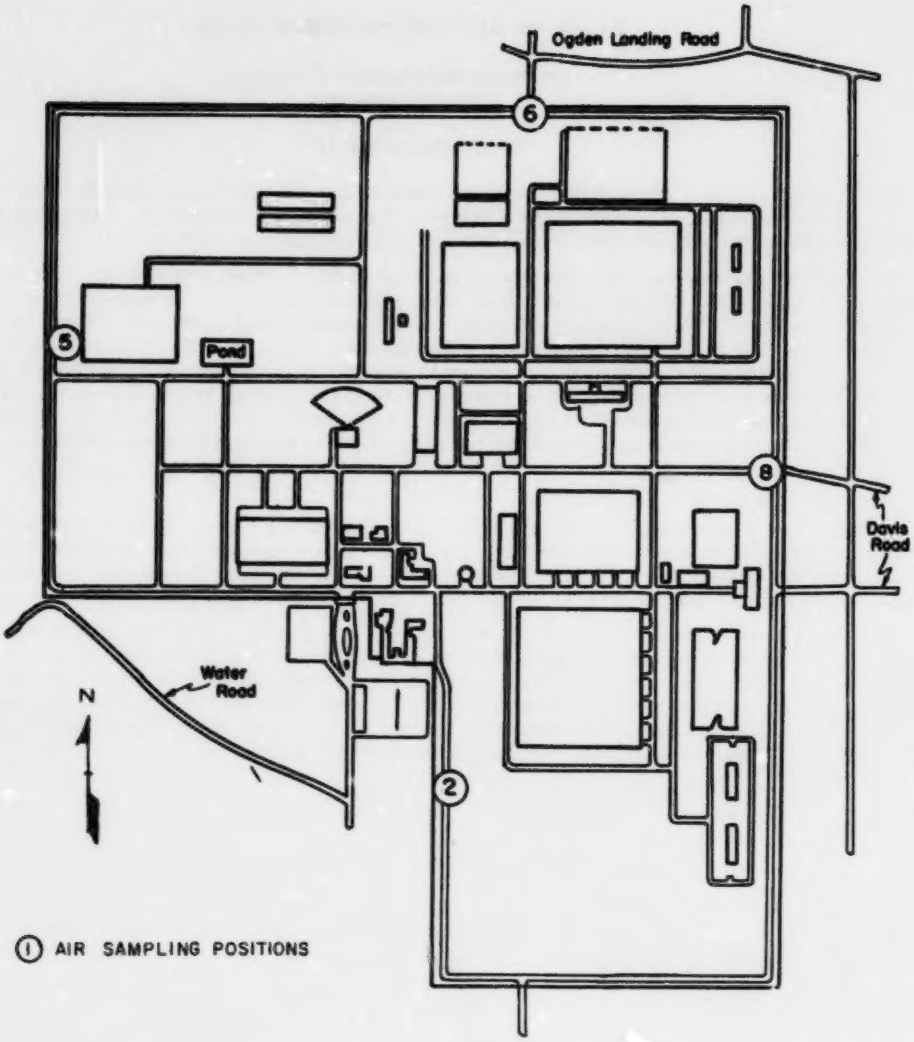
Since no recovery process or filtering system is 100 percent efficient, an environmental monitoring program is required to evaluate the effectiveness of such measures. The Paducah Plant environmental monitoring program consists of a continuing system for sampling the air at 4 stations around the plant perimeter fence and the water at 2 locations in the Big Bayou Creek, 1 in Little Bayou Creek, and 4 in the Ohio River. The results of this monitoring program are presented in tables 1 and 2. Figures 1 and 2 show the locations of air and water sampling points, respectively.

TABLE 1.–GROSS AIR ACTIVITY

(Average concentrations in $\mu\mu c/m^3$)

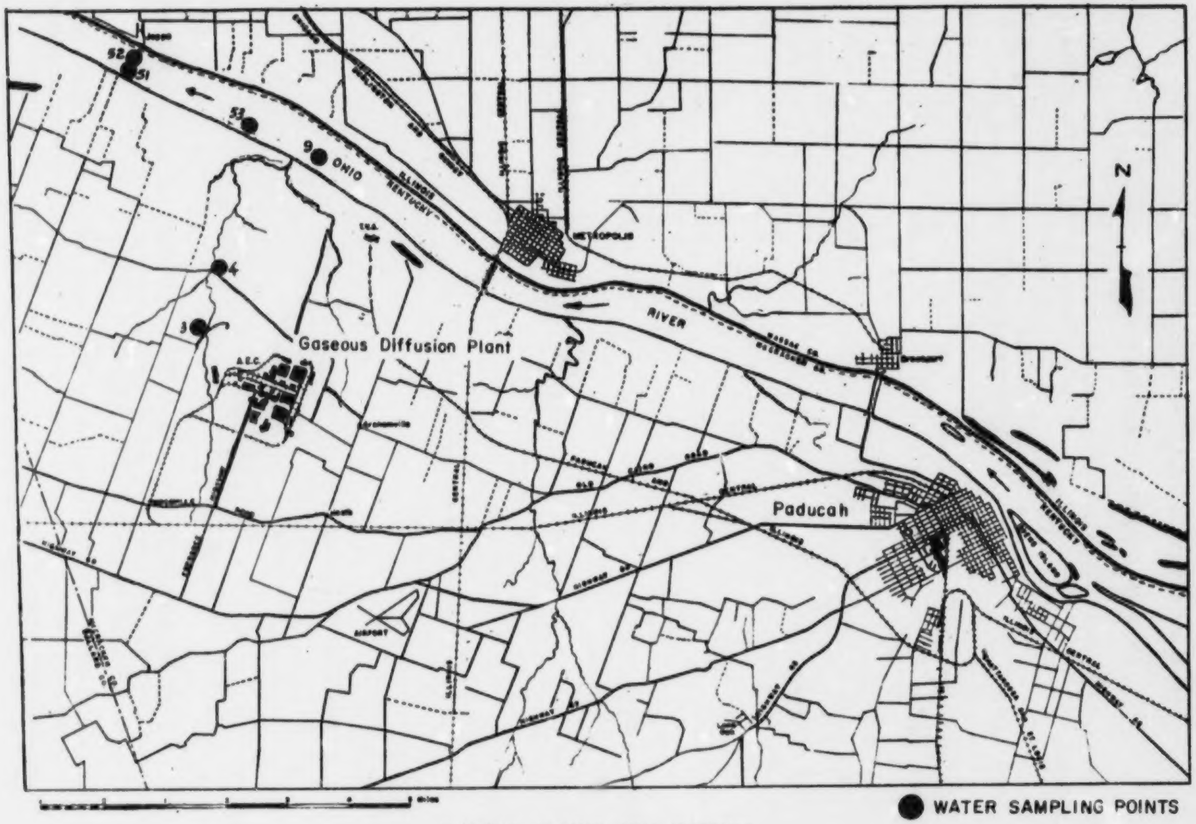
Location number	Type of analysis	Second quarter 1960		Third quarter 1960	
		Number samples	Average	Number samples	Average
2	Uranium*	10	0.25	10	0.27
	Gross beta	10	1.25	10	1.19
5	Uranium	10	.30	10	.22
	Gross beta	10	.59	10	1.17
6	Uranium	10	.57	10	.48
	Gross beta	10	4.74	10	3.40
8	Uranium	10	.31	10	.33
	Gross beta	10	3.39	10	1.79

*The micromicrocurie (μμc) for recently extracted uranium as defined in NBS Handbook 69, page 14, paragraph 3.2 is that amount of U^{238}, U^{235} and U^{234} which emits alpha particles at a rate of 0.0749 dis/sec.


Ogden Landing Road
6
5
Pond
8
Davis Road
Water Road
N
2
① AIR SAMPLING POSITIONS

AIR SAMPLING POSITIONS
PADUCAH GASEOUS DIFFUSION PLANT

FIGURE 1


N
52
51
53
9
OHIO
RIVER
ILLINOIS
KENTUCKY
METROPOLIS
4
3
Gaseous Diffusion Plant
A.E.C.
Paducah
AIRPORT
WATER SAMPLING POINTS

WATER SAMPLING POINTS
PADUCAH GASEOUS DIFFUSION PLANT

FIGURE 2

TABLE 2.--GROSS STREAM WATER ACTIVITY

(Average Concentrations in μμc/liter)

Location		Type of analysis	Second quarter 1960		Third quarter 1960	
No.	Description		Number samples	Average	Number samples	Average
3	Big Bayou leaving Gov't. land	Uranium	13	13	14	17
		Gross beta	13	800	14	500
4	Big Bayou at Ogden Bridge Road	Uranium	3	10	3	7
		Gross beta	3	300	3	500
9	Ohio River above Paducah Plant	Uranium	6	1	6	1
		Gross beta	6	500	6	200
53	Ohio River--below Paducah Plant	Uranium	6	1	6	1
		Gross beta	6	800	6	400
51	Ohio River--south side at Joppa	Uranium	6	1	6	1
		Gross beta	6	1100	6	300
52	Ohio River--middle at Joppa	Uranium	6	1	6	1
		Gross beta	6	700	6	200

PORTSMOUTH GASEOUS DIFFUSION PLANT

Goodyear Atomic Corporation
Portsmouth, Ohio

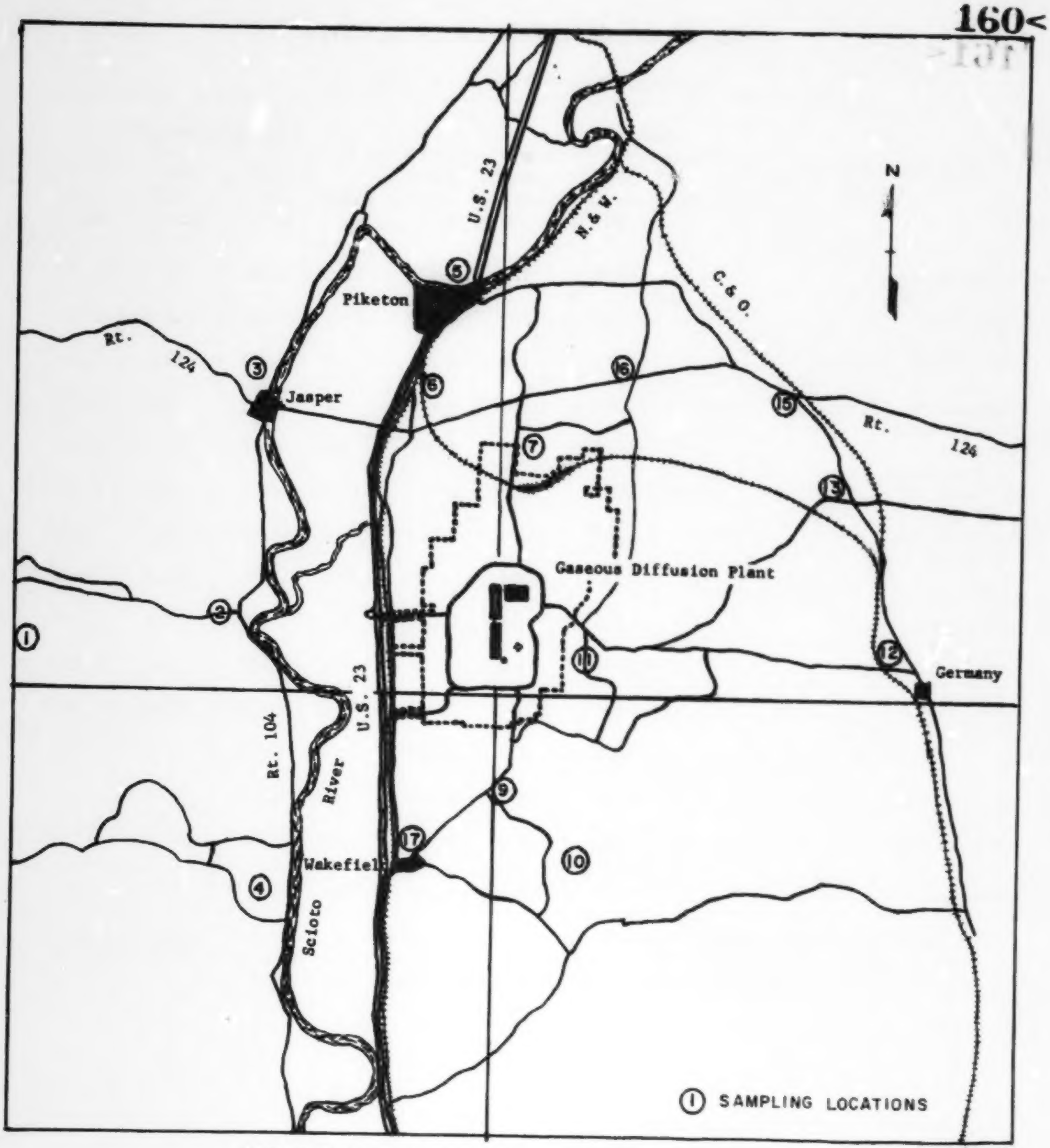
Issued July and October 1960

Environmental levels of radioactivity at the Portsmouth Gaseous Diffusion Plant for 1959 and first quarter 1960 were reported in Radiological Health Data, Volume I, Number 8. The following report presents a summary of the data for the second and third quarters of 1960.

The Atomic Energy Commission facility in Pike County, Ohio, operated by the Goodyear Atomic Corporation, is a gaseous diffusion plant The chemical processing of gaseous uranium presents the ordinary problems of the chemical industry which use toxic solvents and extracting solutions. Fumes and mists must be controlled and contaminants removed by filtering, scrubbing or other practical means to prevent atmospheric contamination.

An extensive environmental survey is conducted on a monthly basis for radioactive materials that may be released from the plant to check the effectiveness of controls which are used. The program is also designed to determine the effect, if any, on the surrounding environment. The routine program consists of sampling water, air and the general radiation background levels. Sampling locations are shown in figure 1.

The results of the environmental survey show that in no instance has the average value for any single location exceeded the maximum permissible concentrations or exposure levels for the population external to the plant boundaries.


N
U.S. 23
N.&W.
C.&O.
⑤
Piketon
Rt. 124
③
Jasper
⑥
⑯
⑮
Rt. 124
⑦
⑬
Gaseous Diffusion Plant
②
①
⑪
⑫
Germany
U.S. 23
Rt. 104
River
⑨
⑰
Wakefiel
⑩
④
Scioto
① SAMPLING LOCATIONS

MAP OF PLANT AREA AND ITS GENERAL VICINITY
WITH SAMPLING POINTS INDICATED
PORTSMOUTH GASEOUS DIFFUSION PLANT

FIGURE 1

TABLE 1.–GROSS STREAM WATER ACTIVITY

(Average concentrations in μμc/liter)

Stream and location from plant	Second quarter 1960				Third quarter 1960			
	Alpha	Percent MPC*	Beta and gamma	Percent MPC*	Alpha	Percent MPC*	Beta and gamma	Percent MPC*
Scioto River 4-5 mi SSW	5.9	0.030	1.8	0.009	12.2	0.061	18.2	0.091
Salt Creek 2-3 mi SSW	4.1	0.021	13.6	0.068	14.4	0.072	18.2	0.091
Salt Creek 1 mi S	4.1	0.021	1.8	0.009	6.4	0.032	40.9	0.204
Big Beaver 3-4 mi ENE	0.9	0.005	13.6	0.068	4.1	0.021	18.2	0.091
Big Beaver 2-3 mi NNW	2.3	0.012	13.6	0.068	5.0	0.025	27.3	0.136
Scioto River 4-5 mi N	13.6	0.068	13.6	0.068	14.9	0.075	36.4	0.182
Little Beaver 2 mi NW	104.5	0.523	108.0	0.540	141.0	0.705	54.6	0.273
Little Beaver 1-2 mi NNW	50.0	0.250	87.7	0.439	128.2	0.641	122.8	0.614
Plant drainage 0 mi SW	3.6	0.018	1.4	0.007	8.2	0.041	31.8	0.159
Plant drainage 0 mi W	3.2	0.016	13.6	0.068	5.4	0.027	18.2	0.091
Plant drainage 0 mi NE	8.2	0.041	122.7	0.614	85.1	0.425	168.4	0.842
Little Beaver 1 mi E	5.0	0.025	13.6	0.068	3.6	0.018	18.2	0.091
Big Beaver 2 mi NW	5.4	0.027	122.7	0.614	50.5	0.253	122.8	0.614
Scioto River 1-2 mi W	3.6	0.018	13.6	0.068	5.9	0.030	13.6	0.068
Average	15.3	0.077	38.2	0.141	34.6	0.173	50.7	0.253

*The values for the maximum permissible concentrations (MPC) for uranium and thorium in air and water are one-tenth of the MPC allowed for continuous occupational exposure as given in Handbook 69, U.S. Department of Commerce, National Bureau of Standards, issued June 5, 1959.

TABLE 2.—GROSS AIR ACTIVITY

(Average concentrations in $\mu\mu c/m^3$)

Location		Second quarter 1960				Third quarter 1960			
Number (see fig. 1)	From plant	Alpha	Percent MPC*	Beta and gamma	Percent MPC*	Alpha	Percent MPC*	Beta and gamma	Percent MPC*
1	5-6 mi W	0.03	1.5	0	0	0.10	5.0	0.95	0.1
2	2-3 mi W	.05	2.5	0	0	.03	1.5	.29	.03
3	4 mi NW	.03	1.5	0	0	.09	4.5	.13	.01
4	3-4 mi SW	.02	1.0	0.40	0.04	.08	4.0	.90	.09
5	4-5 mi N	.03	1.5	.28	.03	.05	2.5	.06	0
6	2-3 mi NNW	.05	2.5	.05	0	.06	3.0	.22	.02
7	2-3 mi N	.29	14.5	.51	.05	.19	8.5	.29	.03
9	1-2 mi S	.01	0.5	0	0	.14	7.0	1.19	.12
10	3-4 mi SSE	.05	2.5	0	0	.11	5.5	.93	.09
11	1 mi E	.03	1.5	0	0	.11	5.5	.46	.05
12	5 mi E	.02	1.0	0	0	.03	1.5	1.06	.11
13	5-6 mi NE	.02	1.0	0	0	.06	3.0	1.46	.15
15	5-6 mi NE	.03	1.5	0	0	.05	2.5	.35	.04
16	4 mi NE	0	0	0	0	.14	7.0	.96	.10
17	2-3 mi SSW	.05	2.5	0.13	.01	.17	8.5	.99	.10
	Average	0.05	2.5	0.09	0.01	0.09	4.5	0.68	0.07

*The values for the maximum permissible concentrations (MPC) for uranium and thorium in air and water are one-tenth of the MPC allowed for continuous occupational exposure as given in Handbook 69, U. S. Department of Commerce, National Bureau of Standards, issued June 5, 1959.

TABLE 3.--GROSS BETA-GAMMA BACKGROUND RADIATION LEVELS

(Millirads/hour)

Location		Second quarter 1960	Third quarter 1960
Number (see fig. 1)	From plant	Average rate	Average rate
1	5-6 mi W	0.022	0.016
2	2-3 mi W	.018	.016
3	4 mi NW	.014	.014
4	3-4 mi SW	.014	.016
5	4-5 mi N	.018	.014
6	2-3 mi NNW	.013	.015
7	2-3 mi N	.019	.016
9	1-2 mi S	.016	.014
10	3-4 mi SSE	.017	.015
11	1 mi E	.019	.016
12	5 mi E	.023	.019
13	5-6 mi NE	.013	.013
15	5-6 mi NE	.016	.016
16	4 mi NE	.015	.013
17	2-3 mi SSW	.017	.018
Average.............................		.017	.015

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FACTORS CONTRIBUTING TO THE OCCURRENCE OF RADIONUCLIDE LEVELS IN MARKET MILK

Division of Radiological Health
Public Health Service

A study of factors contributing to the occurrence of radionuclide levels in market milk was initiated in the St. Louis, Missouri, area by the Public Health Service in cooperation with the St. Louis County Health Department for two main reasons:

1. the demand for more knowledge in a field of high public interest, and
2. a need to determine the principal environmental and climatological factors influencing the concentration of radionuclides, especially strontium-90, in milk.

This study is intended to uncover better practical ways of reducing the levels of radioactivity in milk reaching the consumer.

The present investigation is divided into three phases. Phase I involves a comparison of the climatological, agronomic and dairy husbandry variables among the farms selected for study. This study will be correlated with similar studies in other areas including Brainerd, Minnesota, where differential levels of calcium and stable strontium have been observed. Phase II provides for intensive study of such factors as type and source of animal food, water supplies, level of stable calcium and/or stable strontium, and breed and age of cattle. It will attempt also to determine possible correlations with different radionuclides in the processed milk. Phase III will utilize the information obtained during the first two phases to determine experimentally in the field whether the radionuclide content of milk can be favorably adjusted through dairy farming practices.

The intensified study began during the spring of 1960. The first full year of the study is to be devoted primarily to Phase I with the realization that major changes in methods or points of attack may be necessary in order to fully exploit new leads developed in the course of the investigation. Analytical procedures consist of taking a sample of milk, water, each kind of feed in current use, and soil from each farm at approximately quarterly intervals. Statistical examinations of the resulting analytical data attempt to correlate levels of radionuclides found in these samples with the variables observed during the farm surveys. Analyses of the milk are presently being performed at the Robert A. Taft Sanitary Engineering Center and feeds, soil, water and rainfall samples are being analyzed in the laboratories of the St. Louis County Health Department.

A high degree of cooperation is being demonstrated between the many public and private groups for the successful collection of samples and the conduct of farm surveys. These involve the St. Louis County Health Department, the St. Louis County Radiation Advisory Committee, the St. Louis City Health Department, the Missouri Department of Health, the University of Missouri and Farmers Cooperative Associations in the metropolitan milk shed area. Within the Public Health Service the Divisions of Radiological Health and Engineering Services, including the Robert A. Taft Sanitary Engineering Center complex, are involved in planning, evaluating and developing methodology for the research project.

Between March and November 1960, samples of milk, water, feed and soil were taken at 66 farms on three separate occasions. Of these, 25 farms were selected for intensive study and observation of farming practices. All but six of these farms have been surveyed and two factors have been observed which may prove to be of considerable importance in the ecology of the radionuclides. These are:

1. thin, unproductive, rocky soil, as opposed to deep, productive, bottom land, and
2. occasional or minimal fertilization as opposed to frequent scientific fertilization.

Information pertaining to the above factors subsequently was gathered from each farm. This information and the levels of strontium-90 observed in the milk from the March and August sampling is presented in table 1.

A distribution graph of the farms, arranged in ascending order of the level of strontium-90 observed in the milk samples from the first and second sampling periods, was prepared and studied. This is shown in figure 1. It is noteworthy that very wide variations have been observed in levels of strontium-90 in milk from the farms sampled. Milk from all the farms is pooled, however, and the consumer does not receive milk from any one farm.

The gross beta radioactivity of feeds collected during the first and second sampling periods is shown in table 1. As more data become available they will be published in subsequent issues of Radiological Health Data.

TABLE 1.--STRONTIUM-90 IN MILK COMPARED WITH
FERTILIZATION, AND PRODUCTIVIT

(Radioactivity in uuc/lite

Sampling point	Strontium-90 in milk		Soil type
	March	August	
1	15.9	13.6	Deep
2	15.8	14.6	Deep
3	27.4	21.2	Deep
4	29.1	24.3	Rocky, Shallow
5	42.0	18.2	Deep
6	10.6	8.3	Deep
7	15.9	19.4	Deep
8	12.2	16.1	No information
9	44.4	23.8	Rocky, Shallow
10	35.5	31.5	Rocky, Shallow
11	20.7	15.3	Deep
12	20.2	14.2	Deep
13	21.2	12.4	Deep
14	14.0	17.5	Deep
15	21.8	13.3	Deep
16	11.0	7.3	Rocky, Shallow
17	15.3	7.3	Rocky, Shallow
18	17.8	14.8	Rocky, Shallow
19	6.3	26.8	Rocky, Shallow
20	9.8	13.5	Deep
21	22.6	13.5	Rocky, Shallow
22	20.1	19.0	Rocky, Shallow
23	39.7	16.4	Rocky, Shallow
24	25.8	16.6	Deep
25	25.4	9.5	No information
26	13.0	13.2	Deep
27	12.8	14.3	No information
28	30.8	21.1	Rocky, Shallow
29	12.0	14.8	Deep
30	22.0	16.6	Deep
31	35.4	24.9	Rocky, Shallow
32	35.5	20.0	Deep
33	29.5	16.8	Rocky, Shallow
34	22.6	11.2	Deep
35	14.9	16.6	Deep
36	19.8	15.9	Rocky, Shallow
37	23.9	17.0	Rocky, Shallow
38	No information..........		
39	No information..........		
40	24.9	27.5	Deep
41	24.3	19.7	Rocky, Shallow
42	17.7	13.1	Deep
43	18.3	29.4	Deep
44	37.0	27.9	Rocky, Shallow
45	24.4	10.0	Deep

RED WITH SOIL TYPE, FREQUENCY OF
DUCTIVITY OF THE LAND

in uuc/liter)

e	Fertilization	Productivity of soil
	Frequent	Good
	Frequent	Good
	Frequent	Good
llow	Infrequent	Good
	Infrequent	Good
	Frequent	Good
	Frequent	Good
tion	No information	No information
llow	Infrequent	Poor
llow	Infrequent	Poor
	Frequent	Good
	Infrequent	Good
	Frequent	Good
	Frequent	Good
	Frequent	Good
llow	Frequent	Good
llow	Infrequent	Good
llow	Frequent	No information
llow	Frequent	Good
	Frequent	Good
llow	Frequent	Poor
llow	Infrequent	Poor
llow	Infrequent	Poor
	Infrequent	Good
tion	No information	No information
	Frequent	Good
tion	No information	No information
llow	Frequent	Poor
	Frequent	Good
	Frequent	Poor
llow	Frequent	Poor
	Infrequent	Good
llow	Frequent	Good
	Infrequent	Good
	Frequent	Good
llow	Infrequent	Poor
llow	Infrequent	Good
....	....	....
	Infrequent	Poor
llow	Frequent	Poor
	Frequent	Good
	Frequent	Good
llow	Infrequent	No information
	Frequent	Good

TABLE 1.–STRONTIUM-90 IN MILK COMPARED WITH SOIL TYPE, FREQUENCY OF FERTILIZATION, AND PRODUCTIVITY OF THE LAND–Con.

(Radioactivity in μμc/liter)

Sampling point	Strontium-90 in milk		Soil type	Fertilization	Productivity of soil
	March	August			
46	26.4	21.5	Deep	Frequent	Good
47	11.5	17.4	No information	Infrequent	No information
48	33.0	20.7	Rocky, Shallow	Infrequent	Poor
49	12.4	13.2	No information	No information	No information
50	7.5	19.8	Deep	Frequent	Good
51	18.7	18.0	Deep	Frequent	Good
52	22.0	14.5	Rocky, Shallow	Infrequent	Good
53	23.6	17.6	Deep	Frequent	Good
54	17.5	17.3	No information	Frequent	No information
55	11.4	17.3	Deep	Frequent	Good
56	20.7	20.3	Rocky, Shallow	Infrequent	Poor
57	16.5	9.8	Deep	Frequent	Good
58	9.0	11.6	Deep	Infrequent	Good
59	15.6	10.0	Deep	Frequent	Good
60	17.5	8.9	Rocky, Shallow	Frequent	Good
61	Dropped				
62	24.2	15.5	Rocky, Shallow	Frequent	Good
63	32.4	22.0	Rocky, Shallow	Infrequent	Poor
64	29.1	32.8	Rocky, Shallow	Frequent	Poor
65	37.9	29.0	Rocky, Shallow	Infrequent	Poor
66	12.1	20.4	Deep	Frequent	Good

TABLE 2.--GROSS BETA RADIOACTIVITY IN ANIMAL FEEDS*

(mμc/kg dry weight)

Sampling point	March 1960			August 1960		
	Ensilage	Hay	Mixed meal	Pasture	Hay	Mixed meal
1	7.8	25.1	8.9	15.2 17.1	- -	15.5** 3.80
2	14.7	17.1	15.1	12.9	-	14.1
3	9.0	20.0	6.0	12.0	-	10.4
4	12.7	28.0	8.0	-	-	8.1
5	13.4	45	11.1	16.0	-	12.0
6	8.7	28	10.0	24.9	-	8.4
7	-	12.3	9.8	30.4	-	9.8
8	-	23.3	11.7	12.4	-	11.4
9	-	19.7	9.1	16.6	-	12.1
10	10.1	18.7	10.8	12.1	-	8.0
11	16.0	24.5	6.4	32.2	-	8.4
12	-	14.7	14.4	19.8	-	10.5
13	4.8	10.6	12.7	10.7	-	10.2
14	-	-	11.7	13.6	-	11.0
15	14.4	-	8.0	-	-	8.5
16	14.0	-	9.7	14.0	-	9.7
17	-	112.0	10.2	21.1	-	-
18	12.9	-	12.0	-	-	-
19	-	20.0	11.0	18.0	-	9.2
20	-	32	9.3	14.9	-	9.3
21	-	27.5	11.2	17.9	-	10.8
22	-	26	13.4	-	-	13.1
23	-	26.0	6.8	24.9	-	11.4
24	-	19.3	10.7	8.1 20.2	-	8.0
25	12.6	-	15	8.7	-	13.9
26	18.2	14.3 21.4	10.8	19.4	-	13.7 8.3
27	-	43.	11.8	13.0 25.0	-	8.0
28	-	20.3	12.4	6.0	-	10.5
29	11.4	17.0	13.8	19.4	-	13.5
30	11.4	14.7	9.1	21.4	-	11.5
31	10.6	27	7.6	19.2	-	11.3
32	-	18.0	9.0	54.1	18.2	10.1
33	-	29.0	7.6	-	24.3	-
34	7.1	43.0	9.5	-	-	9.4
35	-	23.0	10.1	-	24.0	7.3
36	-	21.0	12.0	11.4	-	7.8
37	-	19.0	6.2	-	-	9.2
38	-	14.6	4.7	-	-	-
39	5.0	-	12.0	-	-	-
40	19.3	14.0	12.5	17.4	-	10.9
41	-	36.0	12.7	29.2	-	7.8
42	13.1	10.1	11.7	26.2	-	11.8

See footnotes at end of table.

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TABLE 2.--GROSS BETA RADIOACTIVITY IN ANIMAL FEEDS*--Con.

(muc/kg dry weight)

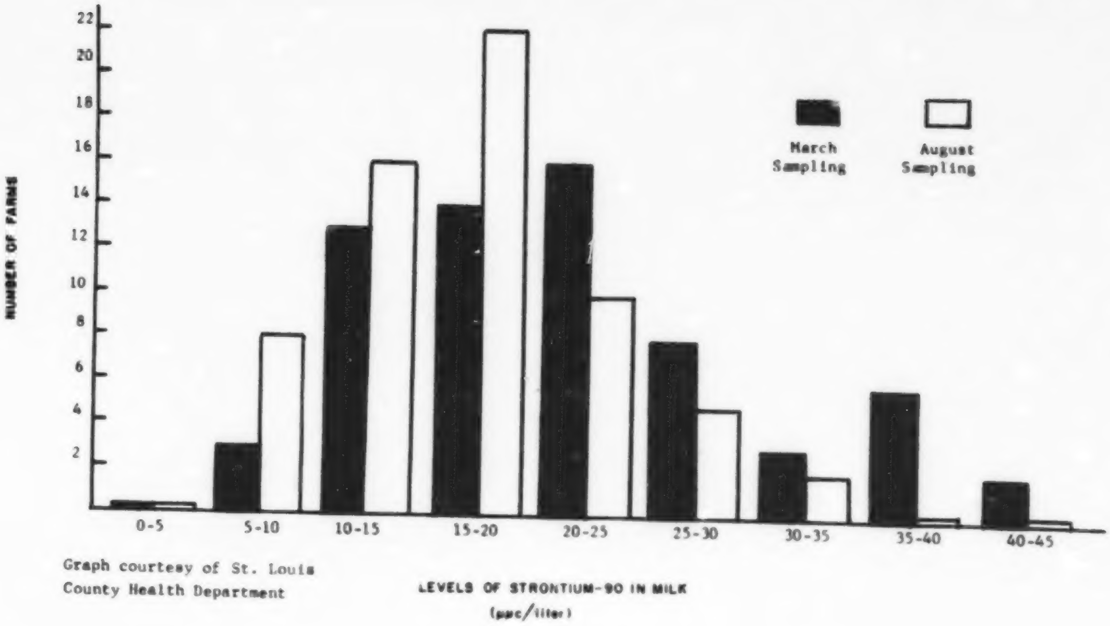
Sampling point	March 1960			August 1960		
	Ensilage	Hay	Mixed meal	Pasture	Hay	Mixed meal
43	-	50	11.3	31.6	-	13.2
44	-	21.0	8.8	13.7	-	14.3
45	8.7	22.3	11.8	31.2	-	15.8
46	9.0	23.0	-	45.4	-	8.5
47	4.5	19.0	3.5 19.6	7.5	-	9.8
48	-	46.0	10.0	26.0	-	13.6
49	11.2	12.3	11.4	10.4	-	6.7
50	10.4	14.3	8.0	25.9	-	10.9
51	11.0	15.0	9.6	19.9	-	10.8
52	10.1	36.0	11.5	-	-	10.8
53	20.4	30.0	8.8	-	24	11.7
54	29.0	-	10.9	16.6	-	12.3
55	16.0	14.9	13.7	22.1	-	12.3
56	-	21.0	12.9	16.1	-	13.9
57	8.1	23.0	7.8	11.4	-	11.0
58	30.0	8.9	7.5	18.4	-	12.2
59	-	21.0	8.3	24.1	-	-
60	-	16.6	12.2	20.7	-	14.5
61	11.9	21.0	19.5	-	-	-
62	14.2	20.1	7.8	16.7	-	11.8
63	-	34.0	8.9	20.4	-	8.4
64	9.1	18.0	11.7	20.6	-	11.9
65	-	46.0	14.0	13.7	-	13.8
66	-	-	-	18.4	-	9.6

*Up to 5% of the radioactivity may be alpha activity. No correction has been made for potassium-40 content.

**Two individual samples taken on same farm.

FIGURE I

DISTRIBUTION OF FARMS
VS.
STRONTIUM-90 CONTENTS OF MILK



Graph courtesy of St. Louis County Health Department

MICHIGAN SURVEY OF MEDICAL RADIATION EXPOSURE DURING PREGNANCY

Research Branch, Division of Radiological Health, and Actuarial Analysis and Survey Methods Section, National Office of Vital Statistics, Public Health Service

The National Office of Vital Statistics in cooperation with the Division of Radiological Health has recently completed a pilot study involving the collection of medical and dental diagnostic radiation exposure histories of women during the one year period prior to delivery of a live birth. The study was conducted from January to July 1960. The primary purpose of the pilot study was to determine optimum sampling techniques for a proposed study of this type to be conducted on a national scale. A secondary objective was the estimation of the kinds of radiation exposure to which the women had been subjected.

A systematic sample of approximately 500 cases was drawn from the birth certificates registered in the State of Michigan. Information was collected by a mail survey among the physicians and dentists who attended the mothers. The mothers were also queried, but no mention was made of radiological examinations. The primary objective of the study was fully realized. From the cooperation received from all sources, it was evident that the collection of information on radiological examinations during pregnancy for a sample of women identified from birth records was entirely feasible by mail survey. The response rate of the various sources queried was as follows:

Source	Percent responding
Physicians............	96
Dentists...............	98
Mothers...............	87

In addition to the high rate of response, preliminary investigations, including a household quality check interview in Detroit, showed that the quality of the data collected was very high.

This study represents one approach in accumulating data for lifetime exposure of the population to radiation from medical sources. The age periods for which estimates of radiological exposure would be derived are particularly important. It is accepted that irradiation of persons prior to or during reproductive ages has a more deleterious effect on the population than irradiation of persons after the reproductive period. Furthermore, there is general agreement that exposure during the gestation period may be the most dangerous time of all, particularly insofar as irradiation of the maternal abdomen is concerned.

Some of the results of the survey pertaining to number and kinds of examinations are shown in tables 1 through 5. Percentage examination rates used below assume that respondents adequately represent the sample. A more complete analysis of the non-respondent and not ascertained groups is in progress.

Table 1 presents the effect of parity (number of previous births), and the apparent effect of age. Of the zero parity women, 51 percent had some type of radiological examination whereas only 29 percent of the first parity or higher mothers were examined.

Of the women under 25, 40 percent received a radiologic examination as compared with an examination rate of 29 percent for women over 25. However, when the effect due to parity was removed, the percentage examination rate in the different age groups did not vary significantly, i.e. 52 percent (under 25) to 49 percent (over 25) for zero parity women and 35 percent (under 25) to 27 percent (over 25) for first parity or higher women.

TABLE 1.--WOMEN DISTRIBUTED BY MEDICAL DIAGNOSTIC RADIOLOGICAL EXAMINATIONS THEY RECEIVED DURING ONE-YEAR PERIOD PRIOR TO DELIVERY OF LIVE BIRTH AND BY AGE AND PARITY

Age and parity of mother	Number sources queried	Number of radiological examinations received						
		None	1	2	3	4 or more	Nonresponse	Not ascertained
All ages	497	300	120	24	4	1	15	33
Zero parity	101	44	37	6	1	0	5	8
First parity	128	80	34	6	0	1	2	5
Second parity	99	63	18	7	2	0	3	6
Third parity or higher	169	113	31	5	1	0	5	14
Under 20 years	51	23	13	2	0	0	5	8
Zero parity	36	14	10	2	0	0	4	6
First parity	14	9	3	0	0	0	1	1
Second parity	0	0	0	0	0	0	0	0
Third parity or higher	1	0	0	0	0	0	0	1
20 to 24 years	151	84	44	9	3	1	3	7
Zero parity	43	20	17	3	1	0	1	1
First parity	59	37	15	3	0	1	1	2
Second parity	23	9	7	3	1	0	1	2
Third parity or higher	26	18	5	0	1	0	0	2
25 to 29 years	138	91	30	6	0	0	3	8
Zero parity	15	6	7	1	0	0	0	1
First parity	39	25	11	2	0	0	0	1
Second parity	37	29	4	1	0	0	1	2
Third parity or higher	47	31	8	2	0	0	2	4
30 years or over	157	102	33	7	1	0	4	10
Zero parity	7	4	3	0	0	0	0	0
First parity	16	9	5	1	0	0	0	1
Second parity	39	25	7	3	1	0	1	2
Third parity or higher	95	64	18	3	0	0	3	7

Table 2 shows the effect of race on the number of examinations. The rate among the non-white group was much greater than among whites. Of the non-white, 60 percent were examined, whereas 31 percent of the whites had examinations.

TABLE 2.—WOMEN DISTRIBUTED BY MEDICAL DIAGNOSTIC RADIOLOGICAL EXAMINATIONS THEY RECEIVED DURING ONE-YEAR PERIOD PRIOR TO DELIVERY OF LIVE BIRTH AND BY RACE OF MOTHER

Race of mother	Number sources queried	Number of radiological examinations received						
		None	1	2	3	4 or more	Nonresponse	Not ascertained
White	444	286	102	21	4	1	7	23
Non-white	53	14	18	3	0	0	8	10
Total	497	300	120	24	4	1	15	33

The effect of income is shown in table 3. Dividing the incomes at $5,000 yields a percentage examination rate of 35 percent for the lower bracket and 26 percent for the higher bracket. This is borderline significance only (7 percent), and therefore the family income effect is questionable.

TABLE 3.—WOMEN DISTRIBUTED BY MEDICAL DIAGNOSTIC RADIOLOGICAL EXAMINATIONS THEY RECEIVED DURING ONE-YEAR PERIOD PRIOR TO DELIVERY OF LIVE BIRTH AND INCOME

Family income	Number sources queried	Number of radiological examinations received						
		None	1	2	3	4 or more	Nonresponse	Not ascertained
Less than $2,500	31	16	9	1	0	0	2	3
$2,500-$4,999	128	70	38	7	0	1	4	8
$5,000-$7,499	155	108	29	8	4	0	0	6
$7,500-$9,999	59	40	11	5	0	0	0	3
$10,000 or more	22	16	4	0	0	0	0	2
Not ascertained	22	12	6	0	0	0	2	2
Nonresponse	80	38	23	3	0	0	7	9
Total	497	300	120	24	4	1	15	33

The month and the general type of examination by age and parity is presented in table 4. The rate for pelvimetries was found to be about 8 percent with a possible range of from 6 to 11 percent (a 95 percent confidence interval). Presumably, only one X-ray pelvimetry was performed before the last trimester. The rates for chest and pelvimetry X-rays were significantly higher for zero parity mothers than first or higher parity mothers (chest X-rays—33 percent vs. 19 percent; pelvimetry X-rays—16 percent vs. 5 percent).

TABLE 4.–MONTH OF EXAMINATION AND GENERAL TYPE OF EXAMINATION BY AGE AND PARITY

Type of examination by age and parity	Total	Prior to pregnancy	Month of examination during pregnancy					
			1st month	2nd month	3rd month	4th-6th months	7th-9th months	Not ascertained
Pelvimetry	37	1	0	0	0	0	34	2
Under 25:								
Zero parity	10	0	0	0	0	0	10	0
First parity or higher	8	1	0	0	0	0	6	1
Over 25:								
Zero parity	4	0	0	0	0	0	3	1
First parity or higher	15	0	0	0	0	0	15	0
Placentography	4	0	0	0	0	0	4	0
Under 25:								
Zero parity	1	0	0	0	0	0	1	0
First parity or higher	1	0	0	0	0	0	1	0
Over 25:								
Zero parity	0	0	0	0	0	0	0	0
First parity or higher	2	0	0	0	0	0	2	0
Chest X-ray	110	12	2	6	13	31	33	13
Under 25:								
Zero parity	25	6	0	1	5	3	6	4
First parity or higher	31	3	0	3	2	10	11	2
Over 25:								
Zero parity	8	1	0	0	0	2	3	2
First parity or higher	46	2	2	2	6	16	13	5
Other abdominal	18	1	2	1	1	2	9	2
Under 25:								
Zero parity	3	0	0	0	0	0	3	0
First parity or higher	6	0	0	1	1	1	2	1
Over 25:								
Zero parity	0	0	0	0	0	0	0	0
First parity or higher	9	1	2	0	0	1	4	1
Other medical	15	4	3	0	3	4	1	0
Under 25:								
Zero parity	1	1	0	0	0	0	0	0
First parity or higher	6	0	1	0	3	2	0	0
Over 25:								
Zero parity	0	0	0	0	0	0	0	0
First parity or higher	8	3	2	0	0	2	1	0
Dental	114	19	9	12	13	35	26	0
Under 25:								
Zero parity	14	2	1	0	3	4	4	0
First parity or higher	21	2	1	2	3	8	5	0
Over 25:								
Zero parity	7	2	0	0	0	5	0	0
First parity or higher	72	13	7	10	7	18	17	0
Total	298	37	16	19	30	72	107	17

Estimates of the expected number of particular diagnostic procedures by parity are presented in column two of table 5. Also, the estimated average and maximum ovarian doses per examination are presented in columns three and four. Fluoroscopic doses were excluded.

As noted above, this study represents one approach to assessing population dose due to medical sources. Estimates of ovarian dose are given below for this population group to present the methodology which could be used to adapt this type of study to the total assessment program.

TABLE 5.–EXPECTED NUMBER OF EXAMINATIONS AND APPROXIMATE ASSOCIATED OVARIAN DOSAGES TO BE RECEIVED IN ONE YEAR PERIOD PRIOR TO DELIVERY BY AN "AVERAGE" MICHIGAN MOTHER

Type of examination	Expected number of examinations in one year	Average dose in one examination[1] (mr)	Maximum dose in one examination[2] (mr)
Pelvimetries:			
Zero parity	0.16	1280	7500
Other	.06		
Placentographies:			
Zero parity	.01	1280	7500
Other	.01		
Chest X-rays:			
Zero parity	.37	0.8	3.0
Other			
Other abdominal:			
Zero parity	.03	125	200
Other	.04		
Other medical:			
Zero parity	.01	50	100
Other	.04		
Dental:			
Zero parity	.21	1.5	100
Other	.23		

[1] "Radiation Hazards II, Measurement of Gonadal Dose in Radiographic Examinations," Webster and Merrill, New England Journal of Medicine, 1957.

[2] "Bone, Skin, and Gonadal Doses in Routine Diagnostic Procedures," Laughlin et al., American Journal of Roentgenology, 1957.

From table 5 average and maximum annual doses may be computed. The results, obtained by summing the products of column two with columns three and four, are given below. The average expected number of examinations per individual was used disregarding the maximum number of examinations that an individual might have received.

Parity	Average	Maximum
Zero	220 mr	1300 mr
Higher	100 mr	560 mr

The data presented here are preliminary in two respects. The survey from which they were derived was primarily designed to study methodology. The radiological health data are a byproduct of that study. Secondly, this represents a preliminary analysis of the data. As previously stated, the non-response and the non-ascertained cases are undergoing further analysis.

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NATURAL LEAD-210 CONTENT OF MAN*

Dr. John B. Hursh, Atomic Energy Project, University of Rochester, has conducted a study to determine the natural lead-210 body burden of man. At least two 10 gram aliquots from the whole body ash of each of 18 cadavers were analyzed for polonium-210. This measurement, converted to disintegrations per unit time, is equivalent to the Pb^{210} activity, since the attainment of secular radioactive equilibrium for the Pb^{210} to Bi^{210} to Po^{210} decay sequence depends on the 139 day half-life of Po^{210}, and since the material was ashed 8 years prior to the polonium measurement.

The results are reported in table 1. Since Po^{210} is in equilibrium with Pb^{210}, the data in column 3 may be interpreted as μμc of Pb^{210} per 10 grams of whole body ash. The concentration of lead—210 averages 0.015 μμc/gram of wet bone.

It is pertinent to note that the individuals whose tissues were analyzed were in the upper age brackets. Since a major contributing factor to the level of body lead is the lead in the environment, and since this has risen during the past several decades, a group of younger subjects, who were actively forming bone mineral, might yield a higher result.

TABLE 1.—NATURAL BODY BURDEN OF Pb^{210}

Age at death (years)	Total ash weight (grams)	Po^{210} net (μμc/10gm)	Total Pb^{210} in vivo (μμc)	Pb^{210} in vivo (μμc/gm of wet bone)
48	4410	0.48	302	0.023
85	1500	.32	66	.015
60	2500	.24	82	.011
57	2100	.14	40	.006
77	1700	.42	102	.020
76	2000	.25	72	.012
83	2200	.47	143	.022
77	790	.35	38	.016
36	2480	.14	47	.0063
74	2260	.47	151	.022
81	1570	.15	35	.0073
66	1970	.27	75	.013
85	2570	.46	165	.021
75	2000	.17	48	--
74	2310	.11	37	.008
33	3190	.44	188	.020
57	2500	.71	238	.032
32	1105	.38	56	.017
Average				0.015

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*Summarized from a report by Dr. John B. Hursh, Atomic Energy Project, University of Rochester, published in Science, volume 132, Number 3440, 2 December 1960. The work was supported by the U. S. Atomic Energy Commission.

RADIATION INTELLIGENCE NETWORK

Division of Radiological Health
Public Health Service

Comprehensive data on radiation exposure sources, dose levels and body burdens are necessary to nearly every aspect of the radiological health program. Data from the several collection networks—air, milk and water—are presented monthly in Radiological Health Data, but are only a part of the total needed data. It is important that these existing collection activities be closely integrated and that the work be extended into presently untouched areas. This goal is being realized through the Radiation Intelligence Network presently being developed by the Division of Radiological Health, Public Health Service. The data gathered through radiological intelligence on population exposure, body burden and resultant dose to the whole body and critical organs form the foundation for assessing and minimizing the harmful effects of ionizing radiation.

As a first step in establishing a comprehensive Radiation Intelligence Network, the Division of Radiological Health is expanding its assay program of determining the amount of radioactivity in foods. The Robert A. Taft Sanitary Engineering Center has conducted some studies of individual foods as reported previously in Radiological Health Data, Volume I, Numbers 4 and 7. The present program is directed to the measurement of radioactivity in the total diet of the United States population. A further extension of the assay on the total diet is anticipated by studies on the dietary components to determine which items are indicator foods. Such foods, which presumably concentrate radioactivity, will be utilized as indices of radioactivity in foods from environmental sources of radiation.

Analyses of total diet samples from two different sources are presently underway. These are:

1. Army Composite Rations. The United States Army has composited rations from 261 items and is supplying portions of the composite to the Division of Radiological Health for radioanalyses.

2. Institutional Food Sampling Program. The Division of Radiological Health, and the Milk and Food Program of the Division of Engineering Services, Public Health Service, with the assistance of State and local health departments are establishing a sampling network of institutions for children. Eight locations throughout the United States are being selected as the first or pilot study phase. A sample will consist of the food equivalent to the three meals and snacks served to some child for seven days. One such composite sample will be collected each month at each institution.

The analyses of the samples will be conducted by the Robert A. Taft Sanitary Engineering Center and the Southwestern and Southeastern Radiological Health Laboratories. Strontium-90, total radium, and gamma scan analyses will be conducted on all samples. The results of the analyses will be reported in Radiological Health Data as they become available.

RADIATION SURVEY REPORT

State of Illinois Department of Public Health

In 1957, Illinois enacted the first State legislation requiring registration of all radiation installations in the State and authorizing investigations by the Department of Public Health for the purpose of studying and evaluating potential radiation hazards. Enactment of the Radiation Protection Act in July 1959 culminated this study. Rules and regulations are formulated and will be promulgated about March 1, 1961.

One section of the Act states that no person shall use radiation in contravention of such rules and regulations as the Department of Public Health may make to regulate exposures detrimental to health. To assure compliance with these regulations, Department personnel monitor and inspect installations of radiation producing machines and materials. Table 1 presents a progress report on 1354 machines inspected through November 15, 1960. Table 2 gives the breakdown of equipment defects according to use. In addition to the 164 industrial x-ray machines inspected, 53 radioisotope sources were surveyed in industry and 12 defects were found. It should also be mentioned that approximately 50 percent of the 164 x-ray machines are used in industrial medical departments. The balance are used for gaging and in radiographic and fluoroscopic industrial applications.

TABLE 1.—RADIATION SURVEY REPORT

Machines Surveyed as of November 15, 1960

	Non-industrial	Industrial	Total
Number of installations surveyed	817	144	961
Number of installations with defects ...	611 (75%)	43 (30%)	654 (68%)
Number of installations without defects	206 (25%)	101 (70%)	307 (32%)

Since November 15, 1960 a greater number of machines have been inspected with a resulting larger number of total defects, but the relative percentages of installations with defects remain about the same.

TABLE 2.--BREAKDOWN OF TOTAL DEFECTS BY PROFESSIONAL USE

Description of defect	Industry	DDS	MD	DO	DC	DSC	DVM	HOSP	Shoe* stores	School	Gov't agency	Total	Percent defects
Inadequate filtration	22	201	78	5	40	9	14	33	0	1	2	405	31.1
Inadequate collimation	14	177	27	1	15	2	1	20	0	1	1	259	19.8
Inadequate shielding	10	34	22	6	12	1	1	16	0	0	1	103	7.9
Excessive exposures	2	1	2	0	0	0	0	0	0	0	1	6	0.5
Short timer cord	1	73	5	0	4	4	0	5	0	0	0	92	7.1
Reposition personnel	4	133	13	0	4	4	0	10	0	0	1	169	12.9
Film badge service	7	28	1	0	0	0	0	1	0	0	0	37	2.9
Obsolete machine (Tube Housing)	2	28	8	1	11	0	1	5	15	3	0	74	5.6
Slow film speed	0	29	0	0	2	0	0	0	0	0	1	32	2.5
Therapy interlock	1	0	1	0	0	0	0	14	0	0	0	16	1.2
Protective clothing	0	1	10	1	2	0	7	7	0	0	0	28	2.2
Holding patients	0	1	0	0	0	0	0	2	0	0	0	3	0.2
Miscellaneous	18	14	17	3	11	1	5	8	0	2	0	79	6.1
Total number of defects	81	720	184	17	101	21	29	121	15	7	7	1303	100.0
Number of installations surveyed	144	396	145	16	89	23	32	75	29	10	2	961	
Installations with defects	43	319	102	12	63	14	24	56	29	4	2	654	
Installations without defects	101	77	43	4	26	9	8	19	0	6	0	307	
Number of x-ray machines	164	459	184	16	93	30	34	291	29	17	37	1354	

Notes: Abbreviations used: DDS, Doctor of Dental Surgery; MD, Doctor of Medicine; DO, Doctor of Osteopathy; DC, Doctor of Chiropractic or Chiropraxis; DSC, Doctor of Surgical Chiropody or Podiatry; DVM, Doctor of Veterinary Medicine; HOSP, Hospital.

*A total of 281 machines was discontinued as a result of the Department's initial action under the Illinois Radiation Protection Act. The figures shown here represent machines surveyed to determine compliance in questionable situations. The fourteen machines shown in the row "Installations without defects" had been removed from premises and destroyed. The fifteen machines in the row "Installations with defects" indicate the unit was still installed but its usage was questionable at the time of inspection.